The Foundry Trade Journal

AND

PATTERN-MAKER.

THE OFFICIAL ORGAN OF THE BRITISH FOUNDRYMEN'S ASSOCIATION.

Vol. I. FEBRUARY, 1906. No. 50.

——PUBLISHED——
THE FIRST WEEK IN EACH MONTH BY
EAGLAND & Co., Ltd.
165, STRAND, LONDON, W.C.

Devoted to the interest and advancement of the Iron, Steel and Brass Foundry Trades.

Subscription Terms: 7s. 6d. per annum, post free.

BRITISH FOUNDRYMEN'S ASSOCIATION.

Presidential Address.

AT the recent Glasgow Conference Mr. R. BUCHANAN, the President, delivered the following address :—

By the goodness of the Governors and the kindly offices of Professor Sexton and the officials of the College, we are privileged to hold the first public meeting held within these magnificent buildings. The foundation-stone was laid by His Most Gracious Majesty the King, who thus signified his high approval and appreciation of the noble work to which this great city has put its hands. When completed it will be the largest technical college in Great Britain. May the work done in it redound to the glory and honour of God and to the fame and advantage of the citizens of Glasgow. (Applause.) My first duty is to thank you for the high honour you have conferred upon me by re-electing me President of the British Foundrymen's Association. I can assure you that for the period I shall hold that office I shall make it not only a duty but a pleasure to further the interests of the Association and of the members of the Association. (Hear, hear.) I believe I may rightfully claim that since its inception the Association has proved itself worthy of the support of the employers, metallurgists and scientific men, managers and foremen, who principally go to form the membership. It may be well to restate the fact that with the monetary relationship of employer and employed we have nothing to do. We are met here for the consideration of practical and scientific questions pertaining to the great industry we in some measure represent. Nor does the usefulness of the Association cease when we part. During the year which has elapsed since last Convention, it has been the pleasure and privilege of many of the officers and members, who may be experts in particular lines of work, to give counsel and help to members who may have trouble and difficulty with castings. Sometimes these difficulties arise from very obscure causes, though the results which arise in the form of "waster" castings are of the most obvious character. By such means we hope to impress upon all connected with the industry the fact that the Association exists solely for the benefit and prosperity of those engaged in it. On these grounds we ask, and ask with confidence, the continued support of those already joined with us, and, in addition, ask further accession to our ranks of all those, whether scientific or practical, employer or employed, who desire the onward advance of the art of founding towards better results by more intelligent and more economical methods. Anyone who has been much in contact with foundry workmen, or, indeed, with any other workmen, cannot but have been made aware of the deep but unreasoning belief, or rather prejudice, that no improvement, or advance, or success in methods of manufacture can come from anyone not directly engaged in the business. When to that you add the fact that most practical men have a contempt for, or actual unbelief in, the utility of any written or printed word, one begins to have some small idea of the magnitude of the work we have before us. It is the beginning of wisdom when one recognises that outside one's little circle of experience and observation there lies a vast and, to us, unknown world, whose mysteries have in some measure been looked into by the eye of genius and of research. We are the "heirs of the ages," and the wealth of knowledge available for all is so great as to make impossible that envy and bitterness which most heirships seem to carry inevitably

in their train. In contrast to the common belief that ideas and improvements come mostly from those engaged in the particular industry, the evidence is much the other way. We are now met in the city and only a few hundred yards from the site of the ancient and famous University where James Watt worked as an instrument-maker to the professors. Here he trained and developed those mighty powers which grew to full fruition at the Soho Foundry, Birmingham, as the greatest mechanical engineer the world has seen. Take another instance. Second only in importance to the invention of the blast furnace itself was the application of the hot blast by Neilson to blast furnaces situated in the outskirts of this city of Glasgow. Was Neilson a blast furnaceman? No! He was an official in the gas works. In later days, Sidney Gilchrist Thomas, who had been a clerk in a London police court, is known to us as the joint discoverer and inventor of the basic process of steelmaking. The problem of making steel from pig-irons containing phosphorus had baffled the most noted steelmakers and metallurgists of the day. Success was reserved for a man who had acquired in a night school the science he knew. One of the pioneers of shipbuilding, the industry for which the River Clyde is world-famous, was Robert Napier, who had been a working blacksmith. The officials of the shipyard which he founded, at their annual dinner lovingly hand round the hammer with which he worked at the anvil. Sir Henry Bessemer was not a steelmaker previous to inventing the acid process of steelmaking by means of the converter which bears his name. Many instances of a similar character could be given. To chemists and metallurgists it is indispensable that their weighing balances should not only weigh accurately, but they must also be sensitive to an almost incredible degree of fineness. When one mentions that chemists' balances are made to turn with the one-ten thousandth part of a gramme, or 0.0015 of a grain, one begins to grasp some idea of the exceeding accuracy of a good chemical balance. Now, the continued accuracy of such an instrument very largely depends upon the hardness of the bearings. Nature provides such a bearing in the agate, a name taken from a river in Sicily, where the stone was found. Was the agate first used by professional makers of fine balances? No! The man who first applied the agate as

ARRIVAL OF MEMBERS OF THE BRITISH FOUNDRYMEN'S ASSOCIATION AT THE CARRON WORKS, FALKIRK.

a bearing for the knife-edges of a weighing instrument was Sharkey, a Liverpool butcher. Now, the citation of these facts would be useless and a waste of valuable time did we not draw from them some lessons. Of these the most obvious one is that outside of our immediate environment and experience there are many brains thinking of, and many hands probing at, the secrets of nature, so that as time goes on there are put into our hands better and more accurate means of production. It is well, then, to keep an open mind ready to receive improvement from whatever source it comes, having learnt by experience to winnow the chaff from the grain. The great advance these last few years in engineering practice by which the speed of machine tools has been increased 20 to 25 per cent., is really not due to anything engineers have done, unless it be in a secondary sense. The credit of this great change in engineering shop practice belongs to the metallurgist and the steel-smelter. The production of what are known as "high-speed" steels, alloys of iron and carbon, which have been made intensely hard by the addition of one or more of the rarer metals—tungsten, chromium, vanadium and molybdenum—made the high speed of working possible. Now, we may take it as an axiom that the industry or the individual that most enlists the aids science, improved tools, and improved methods can give, is certain to advance, and advance profitably. It is a curious perversion of idea when one, a member of an industry which has grown great by change, and by change, advance, should come to the conclusion that change in their case is certain to be harmful. It is said of a business that it cannot stand still, it is either progressing or retrogressing. So it is with the methods of production; advance must be made; there is no standing still or simply marking time. In the various branches of the great industry with which we are connected, namely, the casting and founding of metals, I can see no present indication of any great advance, such as we have seen in the case of "high-speed" steels as applied to engineering, unless it be in the case of the converter of the Tropenas type for the production of small steel castings. Nevertheless, it is incumbent upon anyone who seeks to carry on foundry work to the best advantage that he adds to his armoury all the weapons he can honourably lay his hands to. I am glad we are to have the pleasure of hearing Professor Sexton speak on "Technical Education and the Foundry," as it is a subject which lies near my heart. To my mind, knowledge of the metals and materials with which we work ought to be as familiar to us as is the use of any shop tool. Such knowledge does not come so easily as dreams come in sleep, but those who work for and acquire a fair measure of it will find, as Lord Bacon found and expressed long ago, that "knowledge and human power are synonymous." I have said that there are no present indications of any great advance in the casting or founding of metals, but it is hardly too much to say that were there in every foundry in these islands at least one man abreast of the scientific and metallurgical knowledge applicable to the business, that in itself would form an advance equal to anything we have seen, either in our own or any other industry. (Applause.) To instance a case which came under my own observation:—A foundry, casting heavy castings for marine engines, owing to its geographical position and partly to business connections, used hematites almost exclusively. The waste of money which went on daily for want of some knowledge of metals, and how to mix them to good purpose, was frightful. Those in charge were quite ignorant of the fact that an admixture of the cheapest light scrap iron that could be bought would not only have cheapened the mixture of metal but would have run sounder castings than they were able to produce with pure hematites; and at a very much lower cost. What I have just stated refers to an experience of quite a number of years since, and it is to be hoped much has been learned since then. One's faith that a knowledge of metals is common amongst foundrymen is apt to be of a qualified character when one hears, as I did recently, of a foreman being observed surreptitiously putting a penny into the iron with which he was about to cast test bars. Now, if our friend the foreman instead of throwing his coppers into the ladle amongst the iron would gather them and purchase books which tell of the effects which the various elements have upon iron, he would be using his copper money much more profitably. There he would read that by extensive experiment Lipin has recently shown that the influence of copper on cast iron is not very marked, and is far less than that exerted by other elements. Lipin found that by adding 4.9 per cent. of copper to a Swedish charcoal-iron melted in a graphite crucible, the tensile strength was increased by

3.2 tons per square inch. With copper costing 7d. per lb., I do not think it probable that it is likely to be used extensively for admixtures to be run into iron castings, and I think I may say that our friends the Inspectors will take care it is not run into test bars. Here I would venture to suggest to employers and capitalists owning iron works and foundries the advisability of their providing for the use of those responsible for the work the latest and best text-books which treat of matters relative to the particular business. Some far-seeing and go-ahead business men are doing so now. It is an example which may be largely followed with advantage. It is absolutely necessary for those engaged in productive work that they should keep abreast of the best practice, whether it be scientific or practical. I am not sure that I am justified in speaking of scientific and practical work as if they were separate things. Practical work, to be of the best kind, must necessarily be scientific, and "science is knowledge reduced to system." Some of us use the laboratory and the microscope as adjuncts and aids to foundry work, but to how many foundries would these not prove a delusion and a snare? It was said long ago, "It is amazing with how little wisdom nations are governed." One could truthfully apply the saying to many foundries.

What is still more surprising; one sometimes finds a badly designed, badly equipped foundry, under antediluvian management forming part of a business which in other respects is modern and pretty well all that can be desired. To what causes may we assign this condition of matters? It is largely due, I think, to the somewhat prevalent mistake of not applying to the skilled foundryman for guidance in these matters. Again, one sometimes sees installed in foundries, sometimes at work and sometimes never having been at work, moulding machines which a good salesman had been able to sell to someone high in office, perhaps, but not skilled in these matters. Nevertheless, the foundryman is expected to produce good results, that is, good castings at a low cost, by means of tools and machines in regard to the choice and purchase of which he has had practically no say whatever. I once talked with the head of a large engineering firm who informed me that he had made a number of improvements in the foundry by applying to it a mind unfettered by tradition and custom. Such an one there may be here or there, but the total number of such capable men is not such as is likely to prove an embarrassment. Take the introduction of moulding machines as an instance of what I mean. Many people, not foundrymen, have the idea that the introduction of moulding machines is bound to work as great a revolution in foundry practice as, let us say, the introduction of power-loom weaving was in the weaving industry. There is a field for the moulding machine in producing simple, and what I may term elementary, forms of castings; and even with these good judgment and accuracy have to be exercised for good results to be secured. My advice then is this: give the man in charge of the foundry his choice of the particular type of moulding machine he believes he can produce the best results with, and then hold him to it that he produces the promised results. I believe that the occasions on which he will be found to fall short of his promises in this respect will be few; his reputation for good judgment being at stake. It is not so when machines are put in with practically no reference to his opinion or experience. An apology is due to most of you who listen to me now that I make reference to such an obvious necessity as the supply to the workmen of an adequate number of tools with which to work, so that a minimum of time is lost looking for tools. If one found such a state of matters prevailing in a little poverty-stricken foundry, one would be sorry that such a condition of matters should obtain, but would conclude that the case was past help. But what is one to say when such conditions prevail in large foundries, some of them belonging to limited companies, presumably wealthy? I would commend owners of foundries and managing directors of concerns of which the foundry forms a part, to go occasionally through the foundry and each observe for himself whether there is a full complement of the tools moulders use. Whether the work is being done by day-work or piecework matters not—the loss is there if tools in sufficient number are not available for use. One of the false economists may ask: What of the waste of tools if too many be supplied? That is a state of affairs which I think very seldom obtains, and in reply would call attention to the enormous waste of time the absence of adequate tools causes. It is no exaggeration to say that in many foundries there is more time wasted every week than would supply each man with a new outfit of tools. In foundries paid by day-work these losses are observable at once, but in piecework shops superficial observers are apt to think that the

time lost in looking for and waiting on tools is at the cost of the men. This is a wholly mistaken idea. If the men can make a wage under these conditions, then under the conditions which ought to obtain they would make as much money for themselves as they did formerly, and the costs to the employer would be considerably reduced. What is wanted in such cases is just the application of a little common-sense mixed with some business knowledge. Thus there are foundries in different stages of development, and the proper first step of advance may differ in each case. In many instances the provision of tools and plant, good cranes, plenty of well-designed moulding-boxes, ample blowing power and melting power would in themselves be a revolution in economical production. If these are wanting it is useless to ask or expect the application of scientific principles to foundry work. It is in the works of the wealthy and successful firms where one finds the highest application and development of scientific principles. One may ask whether the wealth proceeds from the application of scientific knowledge to production, or is the application of science only possible to those who are already wealthy? To that I would reply that it is the wealthy and successful firms who draw most benefit from scientific methods of work. Having adopted them they now find they could not possibly do without them, not because it is the mode and gives the appearance of enterprise, but solely and simply because it pays them to do so. They adopt the best tools the engineer can provide, and as a next step call upon the chemist, the metallurgist, and the scientist to continue the progress. It is only the unintelligent and retrograde who think they can afford to do without these things. To such minds finality of method is a great desire, but in these bustling days there is no finality, and we would be foolish to look for it. "The old order changeth, giving place to the new," said the poet Tennyson. So we must adapt ourselves to the changing times. This attitude of mind is not an affectation nor a fashion; it is a necessity for existence. (Loud applause.)

TECHNICAL EDUCATION FOR FOUNDRYMEN.

By Prof. A. Humboldt Sexton, F.I.C., F.C.S.

Professor Sexton, F.I.C., F.C.S., next delivered an address on "Technical Education and the Foundry." Before proceeding with the subject matter of his paper the learned Professor mentioned that the original buildings in which they were gathered were founded in 1796 by Professor John Anderson, and he was a man who came in intimate contact with James Watt. He started the Andersonian College as a Working Man's University. It struck him to have the classes in the dinner-hour, and the workmen attended in their shop clothes. The College had been kept up since, and it was now being developed into the magnificent institution in which they were assembled.

The Professor next proceeded with his paper.

The subject of technical education has been discussed from the platform and in the Press till it must seem that there is nothing new left to be said, and, indeed, until many of us are heartily tired of the very name; and yet it is evident that as we are not all agreed, even on fundamental points, still less on details, the necessity for discussion has not yet ceased. I do not think I should have undertaken to deal with the whole subject, but fortunately that is not required, as I am only asked to speak on the relation of technical education to the one industry with which this Association is concerned; and this makes my task the easier, for I fancy that many of the differences that exist between those who discuss the subject in general arise from the fact that they look at it from different standpoints, with the needs of different industries in view; and as we cannot lay down an ideal scheme into which everything can be forced to fit, but must take circumstances as they are and fit our scheme to them, it will almost certainly happen that each industry will have its own needs, and that what will suit one may be quite unsuitable for another.

By technical education I understand that part of the education which can be given in a college or school which has a direct reference to the work in which a man has to be engaged. I am quite aware that this definition will be considered by many as too narrow, but at the same time it will serve well enough as a basis for what I have to say. It excludes, as you will see, the ordinary primary, secondary, and scientific education which may be given to all alike, whatever their future career, and it excludes that very essential part of all industries which has to be learnt, not in the college, but in the shop, and which,

in one sense, is the real technical education.

The extent to which technical education, as I have defined it, can be given, and the conditions under which it is practicable, will depend on the nature of the industry and on the opportunities of the students. A medical man receives a large part of his technical training in the schools, and gives several years of his time to it. Engineers frequently spend three or four years in the day classes of a college before, after, or concurrently with their practical training in the works; whilst in many other cases, as generally with foundrymen, the only technical education possible is that which can be obtained in evening classes, while the student is devoting his days to actual work at his trade, and in many cases this is, after all, the most satisfactory form which technical education can take. In the training of those who can give their days to study, the United States and Germany are, perhaps, ahead of us, but in the provision for the technical education of those who are actually engaged in daily work this country is unrivalled, thanks very largely to the work of the "Science and Art Department."

In no case can technical education supersede actual practical training in the shop, and the idea that it can do so has done much to bring it into disrepute. All that technical education can do is to give such training as to enable a man to make the very best of the practical training which he gets in the shop, and to enable him to understand intelligently the work which he has to do. It cannot even make a bad workman into a good one, but it can make a good workman a much better and more proficient one. All we know of the material side of things has been obtained by the experience of the senses and reasoning therefrom, and science is nothing more than a classification of what has been already learnt and deducing from the facts obtained general principles under which all the observations fall; and the man, however clever he may be, who sets to work independently of the already determined scientific principles, may attain valuable results, but he will probably find he is only doing over again what was long before done by others, of the results of whose work he might have availed himself. Readers of technical journals can hardly fail to notice how time after time the same idea is published as new, and how even things which have often been tried and failed are re-discovered. Science is but the accumulated experience of the ages, classified and stored for our use, if we only learn how to avail ourselves of it.

Many take up the study of a technical subject under the idea that it will at once make them better workmen, or more frequently with the hope that it will enable them to obtain a better position or a higher wage. This is a great mistake. These may be the ultimate results, but probably nothing of the kind will happen at first. In every industry much of the work that has to be done is routine, or machine work, if one may so call it, for which little knowledge of principles is required; but all that is necessary is the art of performing that particular act quickly and accurately, and such power comes, not by knowledge, but by practice and experience. We all know the difference between knowing how to do a thing and being able to do it, the difference that is between the knowledge in the head and the practical manipulative skill. No amount of mere knowledge can give this skill or can compensate for the lack of it, and as a man's practical usefulness and value usually depends largely on this skill, it will not be increased by any knowledge that he may obtain. Indeed, I doubt very much whether any technical education will make a man a better workman or increase his value to his employers whilst he is working at the same work at which he has acquired practical efficiency. For instance, if a man is a pipe moulder, and intends always to remain in that position, I don't think technical education will be of much use to him.

The foundry industry is, however, much wider than any one branch, and the intelligent, aspiring foundryman does not intend always to remain in the one groove; he hopes to become a foreman, a manager, or, perhaps, to own a foundry of his own, and these are, at least, possibilities. Then for him technical education is of the utmost value.

Foundry work is making rapid advances, and yet in many ways it is behind some of the other branches of engineering industry. The reasons are several: (1) The neglect of technical training; (2) the small scale on which the work is carried on in many establishments; and (3) the secrecy which has been maintained as to methods, so that each man has had to work out his plans independently, without the help of others in the same industry, which always leads to waste of time and energy, and prevents industrial development. This

3rd row: Mr. Mayer, Dumbarton. Mr. Russell, Pendleton. Mr. Allan, Glasgow. Mr. Sperring, Portsmouth. Mr. Newland, Stockton-on-Tees. Mr. Howarth, Broadheath. Mr. Jones, Blaenavon. Mr. Burder, Glasgow. Mr. Sloan, Leeds. Mr. Kershaw, Halifax. Mr. Butler, Pendleton. Mr. Kenyon, Manchester.

2nd row. Mr. Davies, St. Helens. Mr. Riches, Beccles. Mr. Robinson, Leicester. Mr. Kerr, Glasgow. Mr. Fletcher, Kings Lynn. Mr. Ure, Glasgow. Mr. Mead wcroft, Leeds. Mr. Smith, South Shields. Mr. Wilson, Liverpool. Mr. Tattersall, Nottingham. Mr. Pickles Hebden Bridge. Mr. Sands, B'ham. Mr. Dearden, St. Helens.

1st row: Mr. Sherburn, Warrington. Mr. Mason, B'ham. Mr. Vickers, B'ham. Mr. Ellis, S'hampton. Mr. Cook, B'ham. Mr. Finch, Gloucester (Secretary). Mr. Buchanan, Birmingham (President). Mr. Pilkington, Chesterfield (Vice-Pres.). Mr. Morehead, Rugby. Mr. Longmuir, Sheffield. Mr. McFarlane, Salop. Mr. Young, London. Mr. Jones, Cardiff. Mr. Varley, St. Helens.

Photo by J. C. Brown (*Vicar St., Falkirk.*

MEMBERS OF THE ASSOCIATION AT THE GLASGOW CONFERENCE.

Association is likely to do a good deal to overcome this difficulty, and if it has any success in this direction it will do much for the work of the foundry. It is likely also that in the near future much more attention will be given to technical training.

Let us suppose that a foundryman is anxious to acquire technical knowledge. What will he need to learn? How must he set about acquiring the knowledge, and what advantage will he gain when he has completed his studies?

(1.) What subjects should be included in a course of technical instruction for foundrymen? This will, of course, depend much on the preliminary education which has been received, but only those subjects beyond the ordinary school education need be noted. The power of expressing one's thoughts, both in words and in writing, should be acquired, and this can be done by reading and by practice, but cannot be considered as part of technical education, however important it may be.

The subjects will fall into two groups. Those branches of science of which a knowledge is necessary in order to understand the technical processes, and the actual technical knowledge, which is the object to be attained. The preliminary subjects should include:—

(*a*) A good working knowledge of arithmetic, algebra as far as the solution of simple equations, elementary, geometry, and the use of graphic methods of calculation. The last-named, including the use of squared paper, is of the utmost importance.

(*b*) A little skill in drawing is a great advantage. Needless to say, the student need not be either an artist or a draughtsman, but he should be able to make a neat dimensioned sketch of a piece of mechanism, and should be able to understand the plan and elevation of an ordinary mechanical drawing.

(*c*) The elements of chemistry, so far as to be able to understand chemical facts, the meaning of chemical language, and the use of formulæ and equations.

(*d*) A knowledge of the phenomena of heat, as far at least as the phenomena of expansion and solidification and latent and specific heats are concerned.

It is the acquisition of this preliminary knowledge that prevents the greatest difficulty. A grown man has so much to do that he does not like the idea of devoting himself to things of which he does not see the real value; still less does he like the idea of going back to school, which seems to be associated with the learning of arithmetic over again. This is quite natural, and it requires some courage and a good deal of determination to face the labour, drudgery I may say, which is necessary for the mastery of these subjects, and yet if the subsequent work is to be properly understood it must be done, and no young man who gives his mind to it will regret it, though he may have to sacrifice some of his recreations for the purpose.

The technical study will include:—

(*a*) A study of the metallurgy of iron, at least, so far as the methods by which pig-iron is manufactured, to know how far the quality of the metal is under the control of the manufacturer, and how far this may be modified by the processes of manufacture. It is of great importance that manufacturer and user should not regard each other as enemies, but should understand one another's position, so that they may work for the same end, and this cannot be done unless each knows something of the other's methods. A blast furnace manager who is familiar with foundry work will be much more likely to supply iron suitable for foundry use than one who is not, and a foundryman who has some knowledge of iron smelting will be much more reasonable in his demands.

(*b*) The study of foundry work proper. This will include a vast range of subjects, such as the influence of the various constituents of pig-iron on its properties, the fuel for its cupola, cupola design, blowing, moulding sands for various purposes, the principles of the various operations, and the principle on which the various machines used in the foundry are based. This may seem a long list, but it is only a few of many items, and it might have been made many times as long. Of course, each man will pay principal attention to some portions of the subjects, though he should have some knowledge of them all.

It may be asked how long all this will take. Well, I will tell you honestly. All your life. For if you once begin to study your industry, and to look into the details of the work, you will never stop. You will find that each step, each thing learned, will show something beyond which is still to be learned. The only man who thinks he knows everything is he who knows nothing, and whose mind, therefore, has not been opened to the vastness of the unknown. That which is commonly called education is but the beginning of the real education which

lasts the whole life, and the real student is a student till the end.

(2.) How can the requisite information be obtained? Is it necessary to attend classes? Certainly it is not necessary. There are many men who have mastered far more difficult subjects by books, unaided by other help. Almost all that is known has found its way into books somewhere, the valuable unwritten traditions not being very extensive; but it is always advisable to attend classes if it be possible. The poring over books is apt to become monotonous, and it requires immense strength of will to keep at it. For most of us, too, the ear is more efficient than the eye for taking in information, and the magic of the human voice and the personality of the teacher is always a help. The book is but a substitute for the voice, also the teacher can explain difficulties which are often very perplexing to the beginner, and can thus make the path much smoother, and he can save trouble by searching books and collecting the information from all sources for the use of the students. Then from a teacher there is acquired that method of study which can hardly ever be got from books, and, after all, method is one of the essentials to success in learning, and even if the student acquired few facts in his memory the discipline of a course of study could not fail to be advantageous. Wherever possible, science subjects should be studied in the laboratory as well as in the lecture room, so that direct familiarity with facts may be acquired.

In studying a technical subject it must always be remembered that probably the teacher is not as familiar as you are with the technical details of your special branch of the subject, as he cannot have had practical experience in all branches, and, moreover, the details of work vary in every district. It is not his place to teach you the details of your work; his business is to explain the principles on which the various processes are based, and it may often happen that the principle and the actual details may not seem to be in harmony. In such a case, a little study will show whether the difference is real or only apparent, and, if real, which is at fault.

Such a course as I have laid down should take about four sessions, attendance being given on two evenings each week, two sessions being devoted to the preliminary subjects and two to the technical subjects, but under some circumstances the time required may be longer or shorter. Even if the time be limited, I would strongly urge that the preliminary subjects be mastered before the purely technical subjects be taken up.

(3.) What advantages will have been gained when such a course has been gone through? This is an important question, for in this utilitarian age everybody wants to see how much they will profit by anything they may undertake, and especially in such a case as this, where the labour and self-denial will be considerable. The advantages to be gained are many and I think I can show are well worth the labour.

I cannot promise that your wages will be at once increased and that you will be promoted at once to a higher position, because, as you will see, all the study is but a means to an end, that end being more efficient work; and there are many men who have much knowledge but who yet are never very efficient, and who therefore condemn technical education as being useless. Well, they would certainly have been no more efficient if they had had less knowledge. You must make use of your knowledge and prove its value before you can hope to profit by it.

In the first place, it will put you in a much better position to meet the difficulties which you will have to face, and you may be sure that these will come. Lacking knowledge of principles, they are often ultimately overcome by a process of trial and error, but this is always costly and unsatisfactory, and the mastering of one difficulty is no help to the overcoming of the next. Is it necessary to mention the sort of difficulties that crop up in making a mixture, for instance, for a special purpose, and how the problem is often solved? Speaking to foundrymen, I think it is not.

It will enable you to understand the problems of the foundry, many of which are still waiting for solution, and will put you in the way of solving them. The development of an industry does not depend on the teachers or the men of science; it depends on the trained minds engaged in the industry who can see the problems and have them before their minds day after day, and have knowledge enough to understand how they may be approached. In many ways I envy the man who is giving his time to an industry and has daily before him problems waiting for solution. The future of the industry rests with the trained workers.

The great question of economical working must also be faced by the trained worker. Economy is not to be obtained by the rough-and-ready method of cutting

down wages, or by the use of cheap and inefficient labour, but by the design of labour-saving appliances, by using the cheapest materials which are suitable for any purpose, and by the reduction of costs wherever possible, and this can only be done by the application of knowledge. In many foundries there is considerable waste owing to the purchase of high-priced materials, such as iron or coke, simply because the only way those in authority know of securing a suitable material is by buying an expensive make.

From the employer's point of view technical education is excessively valuable, because it enables him to pick out the best men. It is not all who learn who can apply their knowledge, but those who can will soon find opportunity, and employers will soon find them out.

And, lastly, but not by any means least, a course of study will strengthen the mind, and remember that the mind, after all, is the man; it will enable you to understand what you are doing, so that you may walk by sight and not be groping in the dark, and that alone is a great thing, and will give you more confidence in yourself and make you altogether a better man, even if the time never comes for you to apply to practice what you have learnt.

I am quite aware of the difficulties. I know how hard it is after a day's work, beginning at six in the morning, to attend evening classes and concentrate the mind on study. I know how difficult it is to forego the amusements of the present for a probable good in the future, and yet in all respects it is worth the effort, even if only for the strength of character and power of will which it will induce.

The PRESIDENT said they had heard a most interesting paper, and Professor Sexton would be pleased to answer any questions.

A MEMBER asked if the author could recommend any text books?

PROFESSOR SEXTON said there were many books on technical subjects, but he did not feel that he could recommend them as absolutely reliable text books. He could, however, recommend just now to take the "Mechanical Engineer," in which a very excellent series of articles were appearing by Mr. Reid, of the Manchester Technical College. So far as they had gone they were capital, and they were very beautifully illustrated.

MR. MASON (Birmingham) named Professor Turner's work on "The Iron Foundry" and Mr. Keep's work on "Cast Iron" as good text books.

PROFITABLE FOUNDING.

BY J.G. STEWART.

OWING to consideration of time it is only the fringe of the subject that I can now consider, but I am hoping ere long that your Committee of Management will issue notices to the effect that qualified members (individually or as sub-committees) have undertaken to investigate and reply to queries respecting matters of importance to foundrymen, including the much-neglected part of commercial management—dealing with costs accounts, and the simplest and most reliable methods of handling foundry accounts in general.

It is, or should be, the aim of proprietors and managers to so run the plant over which they have control that the year's working will result in the presentation of a balance sheet affording pleasant and profitable reading, and acceptable, in the strictest sense of the word, to all interested parties.

To accomplish this desired end demands hard work, deep thinking, and careful planning on the part of those directly responsible for the success of a business.

Many times we are told that the days of profitable founding are gone, yet from personal knowledge and observation, we may be forgiven for being sceptical on hearing such reports when some with whom we are acquainted appear to be passing rich—the outcome of unprofitable founding, and who, like the butchers, do well out of their losses.

To meet foreign competition, the demands of engineers, the present day keenness amongst buyers, and the ever-increasing call for castings of maximum quality at a minimum cost (so much so that the margin of profit is cut low), it is expedient we should study well our foundry, paying as much or more attention to it than to the machine and fitting shops—if they exist—for while the latter shows the apparatus in the finished stage of construction, it is from the foundry that the foundation of a fine specimen of mechanism emanates.

The more probing the subject receives the more convincing do the proofs become that we may liken the foundry to the goose that lays the golden eggs.

It is said that Carnegie, when asked what he considered the best rule to adopt to enable a man to become rich, advised the "putting of all eggs in one basket

and then setting about watching that *one* basket."

This rule may be applied to the foundry.

The present day calls loudly for specialists and specialities; therefore, to keep abreast of the times, specialise ! Commence your foundry business as you hope to end—well.

There are plenty of opportunities of amassing wealth in the foundry world; it only requires a set purpose, energy, push, and determination to succeed, and ambition to turn out the best class of work possible—in fact, lick creation; then, if you are that man, the commercial world will welcome you after you have been proved by repeated buffeting at the hands of trade conservatism and its disinclination to change. A profitable business is the result of close and careful watching and attention paid to detail, and the detail, if it be authentic, should be as a barometer, indicating with an upward tendency the well-being of the business. Know what you can make an article for and at what price you can afford to sell it.

The success of any business depends upon definite and comprehensive knowledge of every important detail of such business. I do not mean to infer that the management should be equally capable of undertaking the supervision of work whilst actually in progress, or of supervising and checking accounts, but that sufficient knowledge should be in its possession to enable it to intelligently discuss any suggestion for improvement or modification in conference with the heads of respective departments, and, therefore, for a large concern, see that the very best assistance—practical, commercial, and technical—is procured. Do not have a surplus staff, but sufficient to successfully cope with the work with promptitude and despatch, for unless your details are available at almost a moment's call, a leak—if such exists—will gradually assume such large proportions as to ultimately drain the financial resources of a business.

There is a tendency to cut down expenses by employing cheap labour to fill important and responsible positions, but with what result is soon manifest. I do not advocate the paying of high salaries out of proportion with responsibility and efficiency, but just as much as you have to pay the price demanded for a good article, so have you to pay for efficiency and economy. By employing a competent and experienced staff you can reasonably look for profit as the result of your outlay; therefore, efficiency and economy run well in harness. Keep an efficient staff. Do not hire a competent man to-day and discharge him to-morrow. Having got a good bargain stick to it—using judgment. A man who knows he knows what he knows is to be preferred to one who only thinks he knows what he knows he does not know.

To every business man it will be apparent that he should become familiar with the commercial, as well as the practical, branch of the business, and as a great deal of his success depends upon the amount of attention paid to little things he will soon realise the importance of the cost section, for it is here that the key to financial success is found, and to a large extent the prosperity of a firm is the outcome of an efficient and easy cost system. The simpler the system the more efficient and comprehensive can it be made by judicious handling. You will doubtless know of some firms who because another proffers to take a certain order at a price, will go one less to secure the work, irrespective of adaptation or cost, their sole excuse being if So-and-so can do it at the money we ought to. It finally becomes a case of "fools rushing in," etc.—not that I ever heard of an angel showing up for employment in the foundry business.

There are many in this advanced age who never ask themselves "Am I paying too much for this, that, or the other?" who never seek to secure the same terms as the firm down the street, nor do they try to ascertain which class of work pays and which does not; so long as a profit is shown that is all they require. The purchasing of material in the right market and at the proper time; the watching of the market reports, exercising judgment and buying accordingly; the practical, theoretical and technical education and business ability of the management; the accuracy of the estimating and cost departments; the co-operation of the officials, foremen, and workmen, all tend to the success and increased prosperity and profits of an undertaking.

Seek to impress on those in command the advisability of turning a listening ear to the suggestions of those who have the fortune, or misfortune, to be under their control, for it is often from the apparently dull and uninterested that the most brilliant and profitable ideas emanate. To secure an order at a paying price when times are good is one thing, but to begin cheeseparing to enable you to keep your plant employed without showing a financial loss requires some-

thing more than a mere juggling with figures. With the right man at the head of your commercial department, one who is thoroughly acquainted with the requirements of a foundry, working amicably with the heads of the moulding shop, the information requisite for rock-bottom quotations can, and will, be obtained and accurately tabulated. If the principles of commercial enterprise were better understood the more profitable would the business become. Be it a speciality or jobbing shop employed on heavy or light work, it is capable of a certain output. A given output can yield a certain revenue, out of which it is hoped all expenses will be paid, leaving a surplus as profit. The question then to ask is: Are you gaining the maximum output from your shop, if not, why not? Are you receiving the benefits that you anticipated by labour-saving machinery; are you getting the average production per man per day, and are your producers so distributed that the best results are obtained? Do you receive a correct return of the "wasters" made during a given period? What is the proportion of bad to good castings, and what is the amount expended on the production of the "wasters," after making due allowance for the value of scrap resulting therefrom? These are points which, though apparently simple, will bear investigation, and such investigation, thoroughly made, will result in some momentous yet fascinating problems. Do not buy something because it is cheap; in the using it may prove very dear. Do not, because someone offers you a quantity of certain material at a considerable reduction (whether in price or quality is not stated), rush in and buy without first counting the cost. The deal may prove disastrous, in so far as your capital is tied up, and if you have to realise on your bargain makes you worse off, financially, than you were before you entered into the transaction. Therefore, do not tie up all your capital. You can command special terms when you can pay cash.

Look to your labour. See that you do not carry passengers; you cannot afford to do so. If you find you have not sufficient work to keep your unskilled labour fully occupied, and yet you cannot dispense with the services of any one man, then seek to decrease your cost account by securing more orders and putting on extra producers. See that your skilled men do the work for which they are paid. It is not profitable to have a tradesman doing labourer's work. See that careless extravagance and waste does not take place with your loose plant, tools, or stores. A plentiful supply of the usual foundry tools supplied at the expense of the employer is conducive to economical working and profit-making, but a too liberal supply is as bad, if not worse, than a scarcity.

As in a small shop, so in a large one, there are certain limits within which you can work at a profit. A small shop employing, say, three moulders on jobbing work, and a few lads on repetition work, one of the three moulders being proprietor, his working expenses are small, and he is able to control his shop, and at the same time be counted with the producers. Given a fair share of work at profitable prices, he by and by is desirous of taking more extensive contracts or going in for heavier class of work. He extends his shop, takes on, say, two more men and a lad. He now finds it is expedient for him to give up being a producer to attend to the wants of his shop, and it is at this point his troubles begin, and founding which once was profitable now becomes unprofitable. The sticking point has been reached—that point where the business becomes unwieldy for one to manage and yet continue to work on the floor. The responsibilities and demands have so increased that the proprietor knows he ought to cease being a producer, yet the business with its present number of men will not warrant his doing so. He has then two alternatives—either to go back to a small way of business or launch out and seek to increase his output by obtaining new customers and retaining the old ones. With the increase of business fresh responsibilities and liabilities present themselves, but with a keen perception and an application of business commonsense, he goes on from success to success until he emerges from the scrap pile, so to speak, and can with confidence begin to tell his less fortunate brethren that the days of profitable founding are over. In connection with a large shop the expenses are proportionately heavy, and it is expedient that the plant be run, and be kept running, with a certain output, to fall below which will mean a loss or the resorting to a cutting down of wages—either of which are unenviable items to have to our credit. It is, then, a question of taking an order at cost price, for by so doing those orders which yield a profit continue to do so right along the line. It may be you have the refusal of an order at a price. Providing you have a detailed report or chart, furnished periodically, showing the

amount of standing charges at any given output, which amount will include rent, rates and taxes, interest and depreciation, salaries, light, power, etc., you are able to figure back over, and after making due allowance for incidentals you will have a sum left for material, labour, and profit, and you can thus tell almost at a glance whether it is a reasonable price you have had offered. The advisability of reserving a given number of shares in the business, to be applied to certain officials who have it indirectly in their power to increase profits, is worthy of consideration, and will arouse, stimulate, and maintain their interest in their work.

To sum up, for the successful running of a foundry, several points must be carefully thought out; a definite scheme, defined capable of qualification, modification, enlargement, or anything but actual re-organisation or abandonment should be formulated and adhered to. I would place these points under four heads, assuming that the foundry already exists and is sufficiently well equipped for such requirements as are in exact ratio to the capital in command:—(1) Management.—The selection of a suitable manager and heads of departments; (2) Purchasing department.—The purchase of raw material, fuel, and such things as come under the nomenclature of "perpetual necessary supplies"; (3) a controlling system dealing with the intake and output of the business, the cost of production affording a means of keeping definite track of each job and will not allow of a haphazard lumping together of the week's work; (4) Advertising.—"As doubtless some will say "founding is hardly a business capable of extension by means of advertising," I simply mention the matter, but hope when opportunity presents itself to deal fully with the question in another paper. In the meantime, I affirm, and hope to prove conclusively, that the foundry business which, owing to a lack of enterprise on the part of the proprietor, is at present at a standstill, is capable of development to a degree unattainable other than by judicious advertising.

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A SUBSIDIARY company, named the Vickers-Terni Societa Italiana d'Artiglieria e Armamenti, has been inaugurated, with headquarters in Spezzia, Italy, by Vickers, Sons & Maxim, Limited. Mr. A. Vickers is chairman, and Commandatore Giuseppe Orlando vice-chairman. Ordnance work will be the main feature of the company.

THE DEPARTMENT OF IRON AND STEEL METALLURGY AT THE UNIVERSITY OF SHEFFIELD.*

BY JOHN OLIVER ARNOLD.

IN the "Journal of the Iron and Steel Institute," 1891, No. II., p. 93, Mr. B. H. Thwaite ably and interestingly described the Metallurgical Department of the Sheffield Technical School. Much of this pioneer teaching plant was designed by Mr. Thwaite to the author's general specification. For a period of twelve years the equipment rendered excellent service, and established beyond all doubt that the day had gone by when iron and steel metallurgy could be properly taught with an

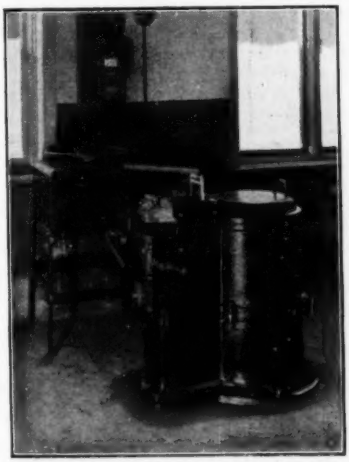

FIG. 1.—ALTERNATING STRESS APPARATUS.

equipment consisting of an assay laboratory, a blackboard, and some chalk. At the end of twelve years the authorities of the Sheffield University College decided that the small pioneer plant should be replaced by much larger and more up-to-date appliances. The first difficulty presenting itself was the question of a site, as it would be obviously impossible to connect the new practical laboratory with other buildings, because the rattle of the travelling crane and the thud of the hammer would evidently be an intolerable nuisance to people in the adjacent buildings, especially during night heats. This difficulty was overcome by Sir Frederick Mappin, the Chairman of the Technical Committee, who secured and personally

* Paper read before the Iron and Steel Institute.

paid for an island site within easy reach of the other laboratories of the department. On this site the unique laboratory about to be described in this paper was built and equipped. Before describing the laboratory itself it may be well to give a brief account of the laboratories to which it is supplementary.

Chemical Assay Laboratories.

These are four in number, providing accommodation for 102 students working at one time. Many of the benches, however, do double duty, a day student occupying it in the day time and an evening student at night. Included in these laboratories is a specially fitted post graduate's laboratory, accommodating eleven students, and designed for the use of managers and chemists in works who may wish to specialise after graduating. It may be here remarked that the Metallurgical Department of the University of Sheffield is unique in placing its evening students on the same footing as day students; and it is interesting to note that out of 39 graduates who have won the Associateship in Metallurgy (an examination about equivalent in severity to the average University B.Sc. in honours) 20 were day students and 19 evening students. These facts fully justify a departure of the Senate adversely criticised by many university men.

Mechanical Testing Equipment.

The mechanical testing apparatus consists of a 50-ton single-lever Wicksteed machine, with two centres, being thus capable of registering tensile, compressive, transverse, or torsional stresses, in either 3-in. or 12-in. ton moments.

An alternating stress apparatus (see Fig. 1) works up to nearly 800 alternations per minute, applying a skin stress slightly beyond the elastic limit, the energy necessary to produce rupture being measured by a delicate integrating Watt

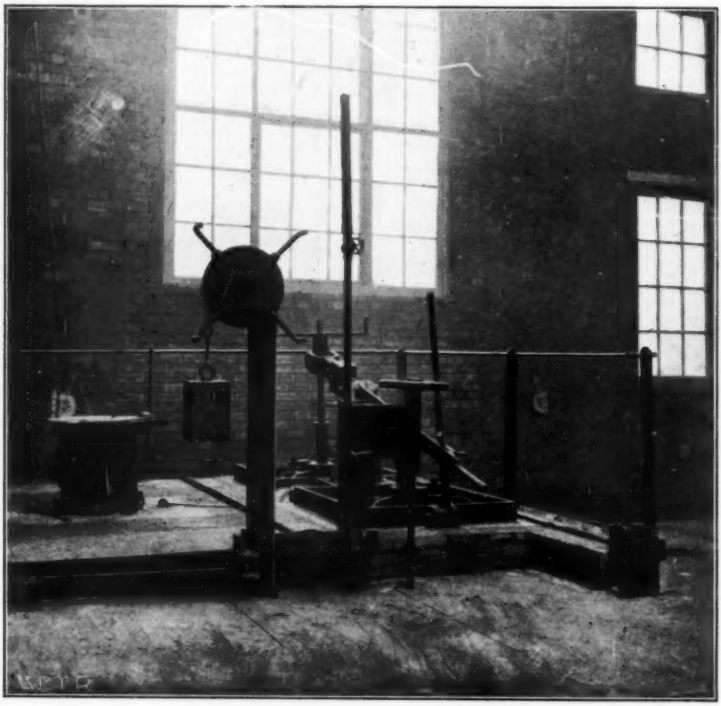

FIG. 2.—NEW GAS-FIRED CRUCIBLE PLANT.

meter. This machine is capable of making thirty or forty tests per hour, thus bringing the almost impracticable Wöhler test into the range of everyday works metallurgy. Researches carried out on this machine have indicated that the idea, largely accepted by engineers, that a high elastic limit makes for safety is erroneous.

The Micrographic Installation.

This consists of a battery of six 4-in. polishing blocks driven electrically by a 1-h.p. motor. There are 11 microscopes, including the latest Zeiss photomicrographic apparatus, illuminated by a powerful Nernst lamp. The dark room is capable of accommodating a maximum of twelve students at one time.

The Pyrometric Installation.

This consists of a central station Le Chatelier pyrometer, which can be connected by means of a switchboard to any of the practical or laboratory furnaces; a Uehling pyrometer connected with the heat treatment muffle to be hereinafter described; a portable photometric dial pyrometer, by Messrs. Baird & Tatlock, Limited; the optical pyrometer of Mesurè & Nouel, and the optical pyrometer by Wanner; a portable pyrometer by R. W. Paul; Siemens' copper ball pyrometer; and Seger cones. In connection with the central station Le Chatelier installation is a furnace for measuring recalescence *in vacuo*, together with a keyboard and an electric chronographic recorder.

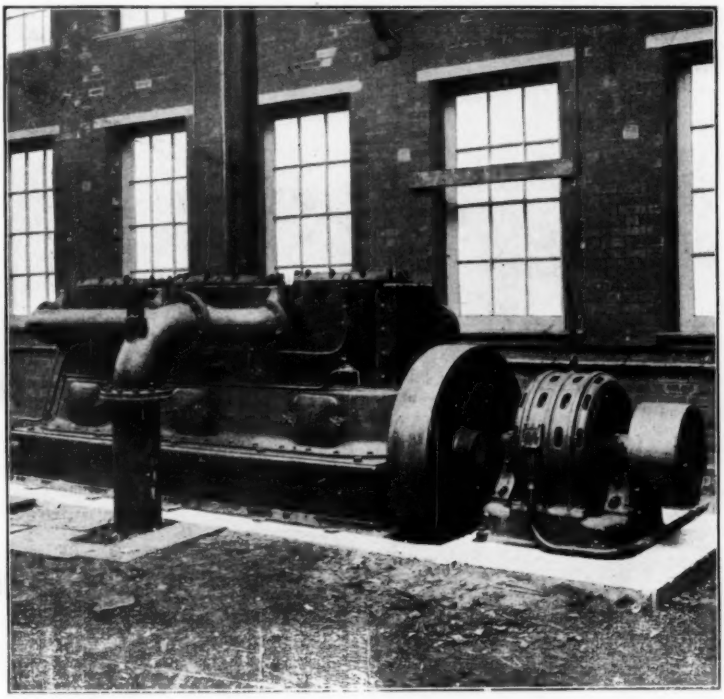

FIG. 3.—CUPOLA BLOWER AND MOTOR.

Geology and Mineralogy.

Geology and mineralogy are compulsory pure science subjects in the metallurgical course, and the practical laboratory is equipped with a set of petrological microscopes and rock section cutting and polishing apparatus.

The Practical Laboratories.

These are two in number, the smaller one being the only portion of the plant erected in 1890 which was not dismantled three years ago. It contains a reverberatory annealing furnace, a four-pot coke crucible furnace, and apparatus for the manufacture of white crucibles.

The Chief Practical Laboratory.

The main objects borne in mind in designing this laboratory were the erection on a manufacturing scale of plant producing steel by the three standard methods of manufacture, namely, crucible, Bessemer, and Siemens steels.

The Crucible Plant.

This consists of a six-pot new form Siemens gas furnace (see Fig. 2), capable of melting 360 lbs. of crucible steel at one time. The economy of fuel in this furnace compared with the old coke system is very great, but it has not yet been decisively ascertained that the gas-melted steel is equal in quality to the coke-melted material.

The Siemens furnace is also of the new form (see Fig. 9), and is capable of making heats up to 2¼ tons. This furnace is also economical owing to the gas retaining the initial heat of the producer, the complete combustion of the tar, and the whole of the regenerative surface being utilised for heating cold air. The ladle is by Messrs. Stevensons, Limited, of Preston.

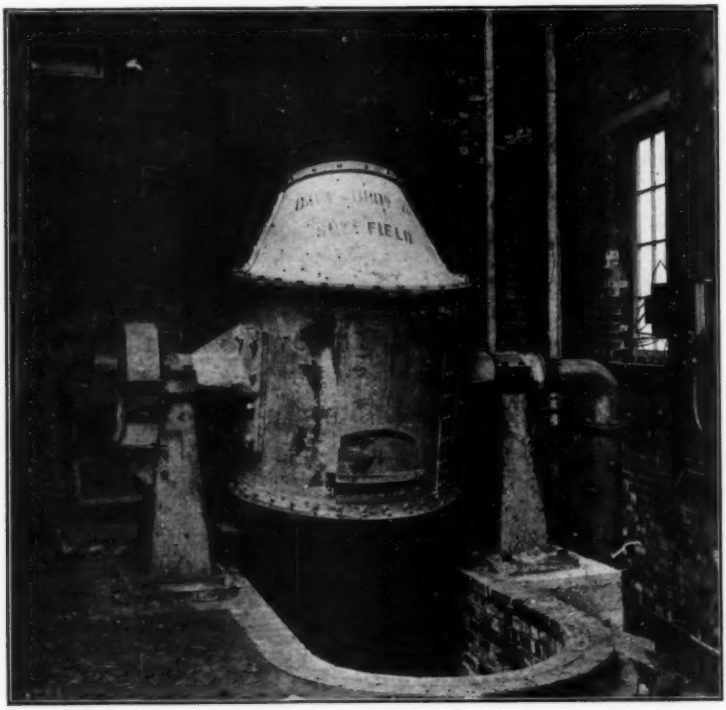

FIG. 4.—BESSEMER CONVERTER AND 20-FOOT-TON DROP TEST.

The Bessemer Plant.

The plant (made by Messrs. Davy Bros., Limited, Sheffield) to exemplify the Bessemer process consists of a 1-ton vessel fitted so as to take a very shallow bottom-blown bath, a side-blown heat by the Robert modification, or a surface-blown heat by the modification of Tropenas (see Fig. 4). The reservoir for the blast consists of a 20-in. underground main 65 ft. long. The blowing engines (made by Messrs. Alley & MacLellan, of Glasgow),

have three cylinders 28 in. in diameter with a 12-in. stroke. They deliver 2,750 cubic feet per minute of uncompressed air, or 2,000 cubic feet per minute at a pressure of 5 lbs. per square inch. The valves are moved positively, the pistons being single acting, and the cylinders water-jacketed. The lubrication is effected under pressure by an oil pump driven off the crank-shaft. This engine is driven by a 115 h.p. two-phase motor.

Other Appliances.

In addition to the main equipment there is a hydro-carbon heat treatment muffle, with 15 square feet of floor space, designed by Mr. Clinch-Jones. (See Fig. 6.) This is connected with the Uehling recording pyrometer. There is also a 20-ft.-ton falling weight apparatus, the mild steel bed-block of which weighs 2¼ tons, and

FIG. 5.—48-IN. CUPOLA FOR BESSEMER AND GENERAL FOUNDRY PRACTICE.

The cupola (see Fig. 5), which serves both for the converter and ordinary cast iron foundry work, is fitted with double spark-catchers, and is made by the Whiting Foundry Equipment Company, of Chicago. The main shell is 48 in. in diameter, lined up to about 39 in. This cupola has a drop bottom. The blast is supplied by an improved Roots blower, made by Sir B. Samuelson & Company, Limited, of Banbury, this blower being driven by a 15 h.p. motor. The blast pressure is regulated by means of water resistance.

was made in the laboratory. There is a smith's shop provided with two drills for drilling spoon samples and ingots. There is also a roomy laboratory for colour carbons. Steel castings and moulds are dried by means of a portable Piftin stove. (See Fig. 7.) A notable addition to this laboratory is an electrically-driven pneumatic hammer, by Messrs. W. & J. Player, Limited, of Birmingham. The weight of this hammer is nominally 7 cwts., but it more nearly approximates ½ ton, and is

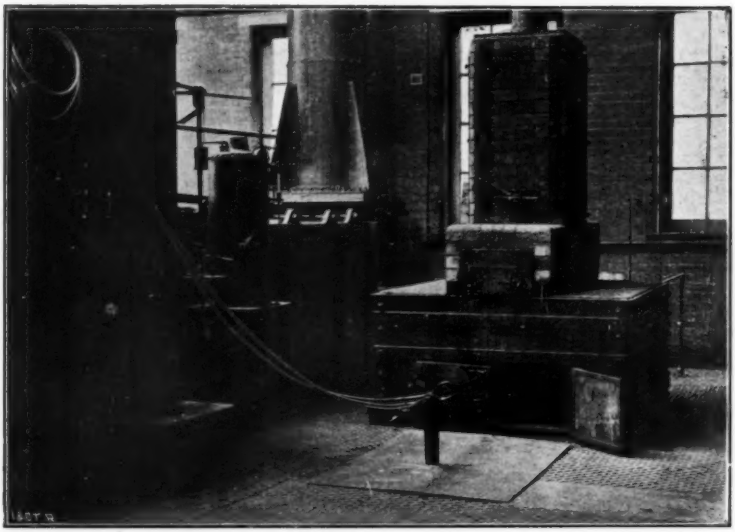

FIG. 6.—HEAT TREATMENT MUFFLE.

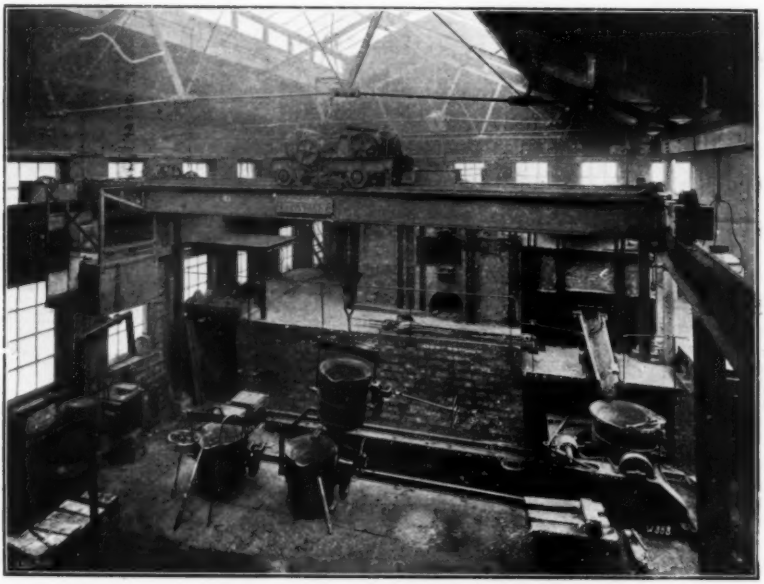

FIG. 9.—INTERIOR OF FOUNDRY.

driven by the blowing-engine motor. It is capable of dealing with 4-in. ingots and striking 100 blows per minute. There is also a coal fire reheating furnace adjoining. (See Fig. 8.)

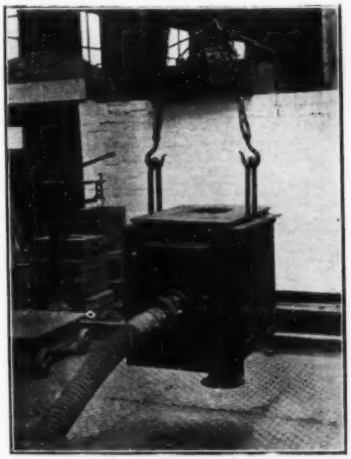

FIG. 7.—DRYING STOVE.

Motive Power.

The motive power throughout is electrical, with the exception of a vertical Cochrane boiler, which works the injector jets of all the furnaces. The current is two-phase, and is supplied by the City Corporation. The foundry is spanned by a 4-ton three-motor crane, by Messrs. T. Smith & Sons, of Rodley. (See Fig. 9.) The aggregate horse-power of the motors in this laboratory is 150. The extent of the experimental operations carried out is exemplified by the fact that during the last session over 40 tons of ingots and castings were made, but unless Government financial support is secured it will be impossible in future sessions to work on so large a scale.

In connection with research work it may be mentioned that since 1889 the staff and students of the Metallurgical Department have published about thirty original researches.

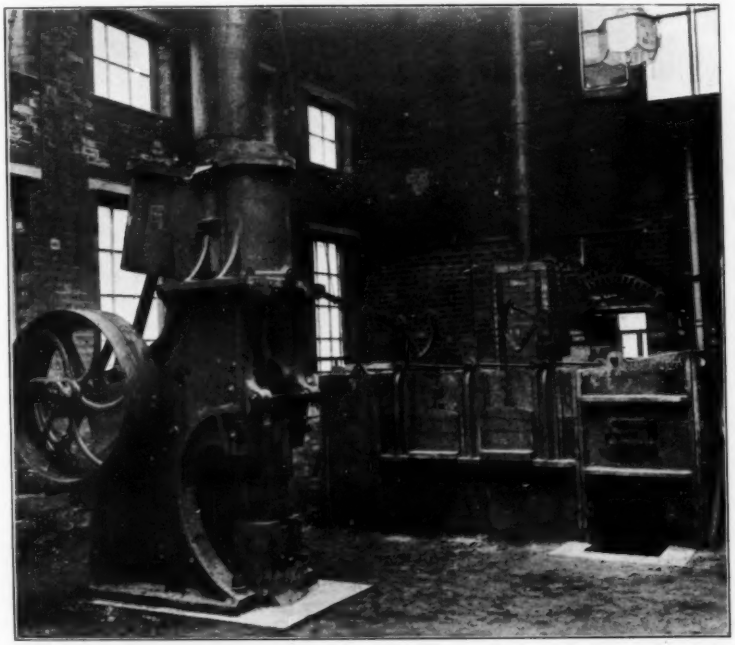

FIG. 8.—ELECTRIC PNEUMATIC HAMMER (22 H.P.) AND RE-HEATING FURNACE.

ELECTRICITY IN FOUNDRIES.

In a pamphlet prepared in order to illustrate some of the advantages which can be attained by the employment of properly designed electrical equipment for driving machinery, the Electrical Company, Limited, of Charing Cross Road, London, show some examples of motor-driven foundry plant. In every case the object in view is the elimination or reduction to the minimum of all superfluous power-consuming intermediate links between the motors and the machinery to be driven. To attain this end in the majority of cases individual driving has been chosen; and the special conditions obtaining in the operation of the particular machine have been given due consideration in the choice of system, type of motor, and method of applying the motive power to the machine in each case. In general, it was the desire of the designer to make the motor and its attachment an intrinsic part of the whole machine, and to avoid anything of a patchwork nature, while saving of space, ease of manipulation, and suitability for hard and rough usage have also received due consideration. Most of the electrical equipments illustrated were adopted for the conversion of Messrs. Harland & Wolff's shipbuilding yards from old-fashioned steam drive, and were carried out by the Electrical Company, Limited, under the direction of Messrs. Harland & Wolff's chief electrical engineer, Mr. Kempster. We show three photos. Fig. 1 shows electrically-driven pug and sand mills driven by 10 h.p. three-phase back-geared slip-ring motors. To get the drives out of the way, the motors are placed above on girders. The gearing is protected from dust and dirt by being enclosed in an air-tight case. Fig. 2 shows an electrically driven Rattler driven by a continuous-current 5 b.h.p. motor direct-geared to the main shaft of the machine. Fig. 3 shows an electrically-driven blowing fan driven by a three-phase slip-ring type 10 b.h.p. motor running at 1,650 revolutions, and coupled direct to the fan spindle.

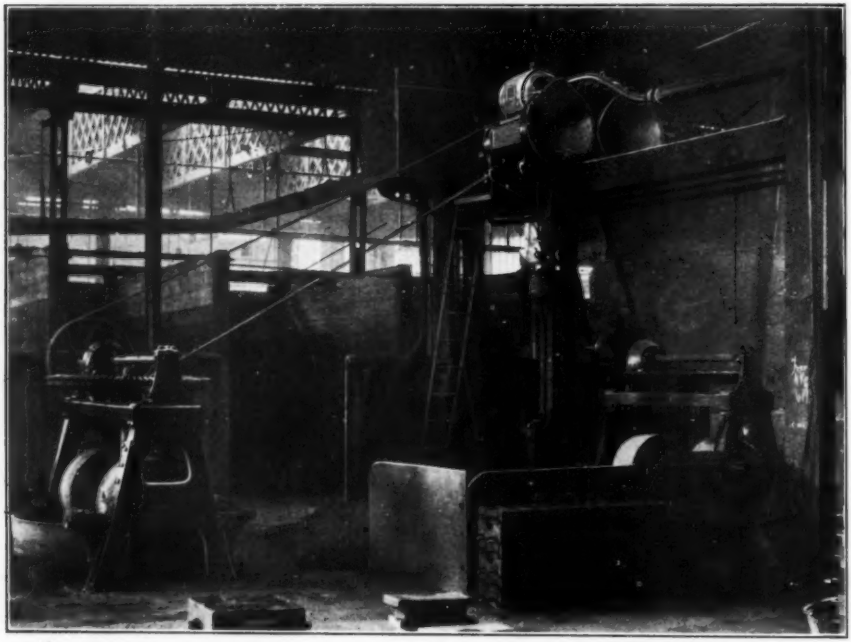

FIG. 1.—ELECTRICALLY-DRIVEN PUG AND SAND MILLS.

TENDENCIES IN THE AMERICAN FOUNDRY INDUSTRY.*

By Dr. Richard Moldenke.

Perhaps the very first thing which strikes the European foundryman who is visiting our plants is the great stress laid upon system and organisation in our strictly modern establishments. The European founder, with his more varied work of smaller aggregate tonnage, casts his pieces one by one and finishes each with the assembling following directly. We, with an eye to the finer economies, prefer to put through an order of anywhere from a dozen to thousands of pieces

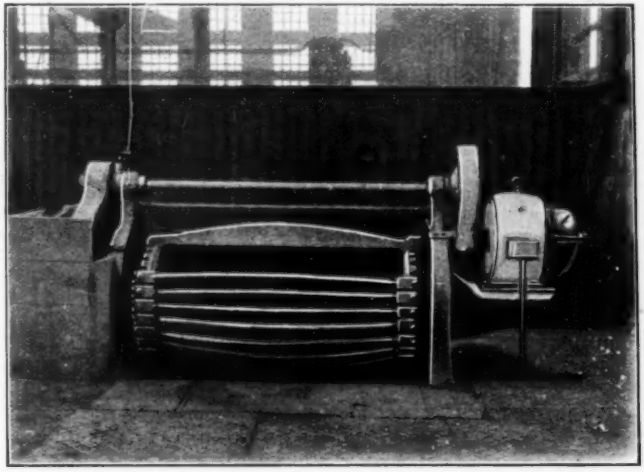

Fig. 2.—Electrically-Driven Rattler; The Electrical Company, Limited.

of a kind, finishing them up for stock and stealing the parts required for sales and promises. As the stock in the warehouses gets below a certain minimum another shop order goes in to fill up the gap. As a consequence the work is always produced at the cheapest rates possible. I have personally known single orders of 100,000 castings of some 30 lbs. each given with simply a blue print of the casting attached to the document. Many times the quantity has been 30,000 to 60,000, which meant that economical work could be done here if anywhere. Actually the figures at which these castings were carried out would be astonishing.

Apart from the use of moulding machines to turn out these classes of castings cheaply, there is a noticeable tendency to economise shop room, and hence moulds are piled as high as they can be conveniently poured. It may be objected that this method oftentimes produces more sprues per pound of casting than the old way, and that if trouble comes a stack of moulds will be ruined instead of only a single one. Yet this system has been found to pay wherever tried, and the getting of more tonnage for a given floor space is bound to spread. The idea, however, should be followed out to its logical end wherever work is made in sufficient quantity. This would seem to be the stacking up of the moulds in fairly deep foundry pits, the iron being brought in large ladles by travelling crane and poured from the bottom of the ladle. Suitable variations in the method can naturally be devised for given cases, but the idea remains the same—to get the greatest tonnage for a given floor space in order to save investment and cost of output.

Sand Treatment Important.

Greater attention will ultimately be given the preparation of the moulding

* A paper read before the New England Foundrymen's Association, Boston, Mass., December 13, 1905.

sand. European shops are far ahead of us in this respect, every foundry of importance grinding its sand to a given standard, then passing it through mixers, which incidentally fill the perfectly uniform material with a maximum of air, thus cushioning the sand and keeping it open. When a highly refractory moulding sand is used this treatment assists in turning out the smoothest kind of work. As our consumers are constantly harping on better looking work this point might be considered more carefully by American foundrymen. Many sands are exceedingly uniform in their natural state, as, for instance, the well-known Albany, the result being highly finished castings where the best moulding methods are employed. On the other hand, who does not recognise a Pittsburg casting—that is, one made in the sand dug in the environs of the Smoky City? Judicious sand treatment would go a great way to remedy the difficulty even there did they make the class of work current in the Eastern States. What great differences may exist in moulding sand in the same heap may be seen in an exaggerated way where sand conveyors are in use. Here, unless special precautions are taken, the loamy particles in the sand may get together, leaving the silicious portions without a binder. The result is that copes drop out, scabs are formed and other troubles come. No wonder that in the ordinary tempering of sand an art is involved which must be acquired before a man can rate himself proficient in this branch of the work. Hence the effort to get away from imperfections in the make-up of the moulding sand heaps by mechanical grinding and mixing. This has not struck our country very hard yet.

Attention may be called here to the marked disposition of manufacturers of foundry facings and other supplies of a like order to learn more of their own art. The foundry industry, as a whole, is bound to benefit by this, and we wish the facing men all success.

We must not forget to mention the growing practice of performing as many operations about the foundry as possible by mechanical means. We have now some excellent examples of what may be done in this way in our advanced foundries. Whether it be the mechanical charging of the cupola, the mould and sand conveyors, metal distribution, compressed air attachments, or yard cranes, this movement is to be encouraged, as wherever the manual labour of several men can be replaced by the brains of only one conditions of management are much easier to meet. The investment may become higher, but competition can be better faced and the resources of the nation employed to the greatest advantage.

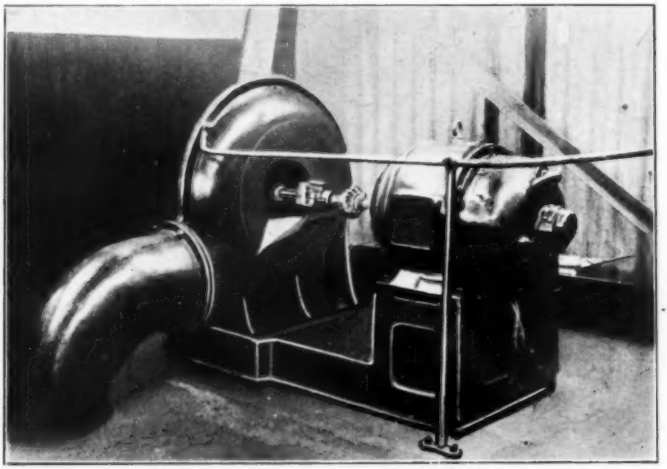

FIG. 3.—ELECTRICALLY-DRIVEN BLOWING FAN; THE ELECTRICAL COMPANY, LIMITED.

Standardising Demanded.

There is a growing demand for foundry standards. Thus flasks, pattern work, and the moulding methods depending upon the close co-operation of the pattern shop with the moulding floor are coming in for considerable attention. The makers of moulding machines will be greatly benefited by this desired standardisation of flasks, for the time has now gone by when a manufacturer would go out of his way to get the most impossible screw thread in order that the repairs subsequently necessary would have to come to him. We shall undoubtedly see the day when all the designs of the draughting office of an industrial establishment will go for revision to its foundry superintendent in order to standardise the non-essential elements therein and create less labour in producing castings.

In going through many a foundry where very large loam moulds are made for stock work one cannot help regretting the tearing down of much of the mould which might be left standing if the subject of permanent moulds had been studied more carefully by the foundry foreman. The effort to-day is to economise in every way possible, and very often here is a chance to begin.

We owe much to our high-class custom pattern shops for the progress they have forced upon the pattern end of our industry. It is not so long ago that metal patterns were unheard of in many foundries. It seemed like a waste of good money to put more time and effort on a pattern than was required by the ordinary article we all have piled on our pattern shelves. However, many a shop to-day can boast of a set of metal-cutting machines which remind one of a first-class tool room. This tendency is, however, closely interwoven with the specialisation of the foundry, and where a first-class man is in charge the pattern storage soon becomes less of a graveyard for obsolete material.

Greater Use of Steel Scrap.

Turning now to the melting and the closely allied laboratory, we see that the most strongly marked feature is the production of higher grade castings by the addition of steel scrap—or, in other words, the reduction of the total carbon in cast iron, making the crystalline structure more closely adherent, and hence the whole casting stronger. Here the skill of the melter is joined with that of the chemist, so that value is received from the higher priced stock charged into the cupola. The cupola process is being studied more carefully, and experts in that line can produce results close to those of the air furnace or open-hearth. Considering that this is accomplished with fuel and metal in contact, and by a notoriously unsatisfactory melting method, which the cupola process undoubtedly is from the standpoint of the treatment the metal gets in it, the foundry industry is to be congratulated upon its ability to retain a strong hold on the making of castings in the face of the hard knocks it is getting from the steel-casting establishments. This movement towards better grades of metal is but in its infancy. The cupola, which is a cheaper melter, will undoubtedly be improved, with the view of getting better results from the steel scrap additions. The metal will be safeguarded more from burning, and the additions of the scrap will be systematised more, so that a given quantity will produce given results more regularly than is now the case.

The tendency above mentioned has somewhat retarded the introduction of air furnaces in general foundry practice. However, taking into consideration the demand for better irons, better coke, better melting methods, the specialist founder will soon tire of buying high-class material and spoiling it or taking big chances in that direction. He will naturally revert to the air furnace as better able to give high-class results from high-class material, and the consumer will be glad to pay the difference.

Conservative Prices for Castings.

Those who have taken the trouble to follow the silver and copper market will have noted that the high levels reached are not due to spasmodic fluctuation made by financial manipulation, but are the result of a real ability on the part of the civilised world to absorb these metals. We have the same thing in the iron market. The swing of the pendulum from the 22,000,000-ton mark will soon carry the consumption of the metal far into the thirty or forty millions, and unless the country can produce this quantity steadily the price is bound to rise sharply. To-day we find few men in our line of work who are out for abnormally high prices for their product. We all wish for nothing better than a fair profit on base purchase prices, which are fair to the furnace and coke dealer, as well as to us. Hence, the output of our establishments will be kept as much as possible within conservative price limits, and the quantity will be made to increase gradually. It may be said, however, that the resources of the country

will not be able to respond quite as fast as the demands the rapidly increasing population is making upon them, and hence we will never see the days of 1894 prices again, for which let us be thankful. All this means that with better prices, even if pig-iron and coke hold well up, a more liberal tendency in the way of investment is bound to manifest itself, and everybody will be the gainer.

Whereas, once the melting point of the various cast irons formed the one absorbing topic for articles and discussion, at present it is the elimination of sulphur in the cupola. This is a good sign, and even if one man finds that he cannot get the results of the other, and, therefore, we are at present quite at sea regarding a desirable method, yet it shows a tendency, and a good one.

The Electric Furnace for the Foundry

This brings us to the consideration of another matter. The Canadian Government is doing much to foster the development of electric smelting. The makers of the latest types of electric furnaces are constantly getting better efficiencies. Now, with a cheap gas in a gas engine, and for the making of very small castings in small quantity, there is no reason why the small steel and bronze foundries should not melt their stock in the electric furnace. The higher price of the work sold will probably stand this. This matter will bear watching. I have recently noticed the suggestion of Dr. Waldo, of New York, for the making of Bessemer steel rings or suitably shaped small ingots, these to be of the composition of the steel casting. Now, by charging these small ingots into the electric furnace, one obtains a fluid steel of the proper composition to cast. I would suggest as an improvement that the ingots be preheated up to the highest point possible without injury to the metal—say, just as the ingots for rails or structural steel are treated. This would leave for the more expensive electric current only the finishing heat necessary to melt and superheat to the point right for pouring.

The considerations presented above will show our foundrymen that we are by no means through with the improvement of our processes, and were it possible to enlist an active encouragement on the part of the industry many of these very direct problems could be attacked and possibly solved.

The Direct Metal Process.

Finally, we come to the general problems of the foundry, in which there are also marked signs of a change. This will probably affect only the very large industries for the present and next generation, but what may come after is hard to say. Foremost stands the rapidly increasing use of direct metal. This is more marked across the water, but is bound to come here also. The big segments for the tunnel shields and linings should never have been made of remelted metal. However, this does not mean that it was advisable from the first to jump into a new method for such vast contracts. Here, again, we strike the importance of the use of steel scrap in grey iron castings in order to reduce the total carbon. I would not advocate the use of direct metal just as it is, but to have the stream of metal from the blast furnace go into large heated mixers, which means greater—in fact, more easily attained—uniformity than is ever possible with the cupola. Now into this mixer there should be charged successively quantities of steel scrap which has been heated up almost to melting. This accomplishes a twofold purpose. First, it gives a reduction of total carbon without lowering the temperature of the metal in the mixer too seriously to be corrected at once by the heating method used, as well as the comparatively large quantity of metal that should be in the mixer all the time. Now, the first result is the making of a high grade cast iron. This iron should be good enough for all the purposes the process could be used for, such as the making of pipe, tunnel segments, ingot moulds, etc.

The second effect of the addition of the preheated steel scrap is that the problem of kish is done away with. This is the bugbear of the direct metal foundry, and, in fact, has retarded the introduction of direct metal for important work so much that at one time it was thought out of the question to think of ever going back to this ancient way of making castings.

What, then, will be the result of this tendency? It means that blast furnaces will be located wherever the raw materials not only are favourable, but where there is a good shipping point for pipe, possibly car wheels, and not impossibly malleable castings for car work. The furnace proposition will then become one of allied industries to give an outlet for the pig-iron made which will fit these uses, and all the pig-iron not of composition to go into the various mixers will be put upon the market.

While this seems visionary, it is nevertheless a fact that one very large combination is about to break ground for just

such an establishment, and we may hear from direct metal pipe very soon. With our American enterprise one hesitates to say just where these changes in method of production, as well as administration, will end, and it is even within the range of possibilities to find stoves made at a blast furnace once the moulding machine has conquered the field that is before it in that line.

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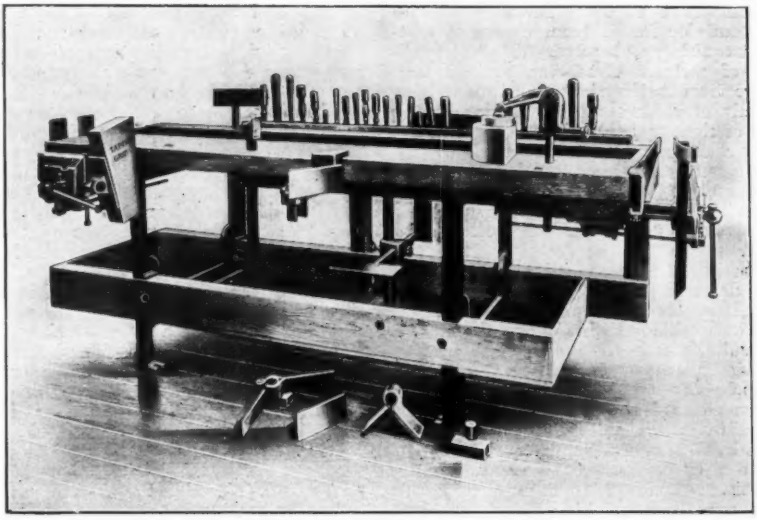
AN IMPROVED PATTERN-MAKER'S BENCH.

MESSRS. RICHARD DAVIES & SONS, of Bilberry Street, Manchester, have recently put upon the market a new pattern-maker's bench, known as the "Perkins" bench. It was designed by Mr. Perkins, who is a large pattern-maker to the trade, originally for his own use, and finding it of great assistance to them, Messrs. Davies decided to put it on the market. A few of the points in the bench, which is shown in the annexed cut, are as follows:—The vices are patent quick-grip vices, fitted with a loose attachment that in turn fits all attachments for various shapes of work to be done. There is the taper attachment which adapts itself to any taper, as do the circular attachments, which are shown displayed on the floor. By fixing what are called "steels" it is possible to grip large patterns on the top of the bench from the grip on the extreme right of the bench, and again from front to back of bench. If the pattern or job is too large to put on bench it can remain on floor in front or end of bench and still be held by the same method. The movable bracket or rest is to hold up any work not on the floor. If the workman requires a clear or full bench, the tool rack is lowered clear out of the way without removing the tools, and is just as quickly raised when required. The makers claim that there is no bench at present in use that a workman can alone, without help and waste of time, handle the largest patterns or the smallest and most delicate pattern as easily and quickly as can be done on this bench.



PATTERN-MAKER'S BENCH BY MESSRS. RICHARD DAVIES & SONS.

Experts, pattern-makers, and others who have seen and examined the bench, agree that it is one of the most novel and universal additions to the pattern shop that has yet been introduced.

FERRO-SILICON IN TH FOUNDRY.*

By A. E. Outerbridge.

Among the comparatively new metallurgical products for which I think an increased use will be found, is an exceedingly rich ferro-silicon alloy, containing from 50 to 80 per cent. of silicon.

Ferro-silicon containing from 12 to 20 per cent. of silicon has been a commercial product for a long time, but the new very rich silicon alloy possesses distinctively valuable properties which I have discovered in the course of some extended investigations not heretofore published.

One of the difficult problems of foundry practice where miscellaneous castings are made is to economically obtain from one melting in a cupola different grades of iron suitable for different classes of castings requiring perhaps very different qualities of metal. Thus, the articles may range from castings of many tons weight, usually of thick section, requiring strong iron of close grained texture, often having high chilling properties, to small objects of a pound or so in weight, frequently of thin sections, which require to be machined, and therefore must be of softer metal having little or no tendency to chill.

As silicon is practically the governor that determines the degree of hardness of cast iron, the value of a simple process that will enable the intelligent founder to control the proportion of silicon in any individual ladle of molten iron drawn from a cupola is apparent, especially in foundries where miscellaneous castings, ranging in size from small pulleys weighing a few pounds, with rims one-quarter inch thick, up to anvil blocks, bed plates for various machines, hydraulic cylinders, and the like, sometimes weighing many tons and of varying thickness, up to 12 in. or more, as is the daily practice in the foundry with which I have been connected for many years. The silicon in such castings ranges usually from 2½ per cent. to less than 1 per cent., and the customary method of operation is to group all the small work, so that it will be cast at the beginning of the heat, followed by a medium grade of iron suitable for miscellaneous castings of medium weight and thickness, this, again, followed by large and heavy work requiring strong iron of close-grained texture, low in silicon, and having high chilling properties.

By arranging the work so as to have a certain number of castings to serve as "buffers," *i.e.*, to take iron that is intermediate between the different grades charged in the furnace, this method has proved very satisfactory, and now it can, I think, be supplemented by altering at will the silicon in any individual ladle to a nicety that is truly surprising.

In this way it is possible and practicable to use a lower grade of iron in the general mixture than could otherwise be done. At present the operation is confined to treating ladles of iron for the lightest class of work, requiring the softest grade of iron, so as to permit of machining at high rates of speed; but, when the price of ferro-silicon, containing 50 per cent. and upwards of silicon, shall fall, as I have little doubt it will, to a more reasonable figure, the use of it in the way I have here indicated will become general. I am led to make this assertion from experience based on my original investigations with ferro-manganese (80 per cent. manganese) in car-wheel iron in the year 1886. The cost of ferro-manganese was then more per ton than the present price of ferro-silicon (50 per cent. silicon). To-day it is less than half that price, and the use of ferro-manganese for certain purposes, especially in chilled cast iron car-wheels, in the way I described in my lecture on "Cast Iron," printed in "The Journal of the Franklin Institute," March, 1888, and in practically the same proportions, has long since become well established. It has been stated in print by a recent writer that when the Pennsylvania Railroad authorities adopted the "thermal test" for car wheels, the wheels of nearly all the makers failed to stand this test, until a small quantity of ferro-manganese was added in the ladle just before pouring. This gave the metal additional elasticity that enabled the wheel to resist the severe strains caused by heating the rim suddenly in the thermal test.

As the result of a large number of experiments made with test bars of foundry iron treated with small quantities of ferro-silicon (50 per cent. Si.), say one-quarter to 1 per cent., I have found an average gain in strength of about 15 per cent., and a somewhat larger average gain in ductility, or bending quality, accompanied by a marked increase in softness of the metal.

I have here a number of test specimens of the treated and untreated iron: those which show most plainly the softening effect are the wedge-shaped castings 6 in. long, 4 in. wide, ¼ in. thick, tapering to a feather-edge, cast of medium grade foundry iron and split down the middle to

* From the "Journal of the Franklin Institute."

show the grain. In some of these the untreated sample is white all through, in others it is white at the thinnest portion only, but in all the specimens cast from the same ladles after treatment with from one-quarter to 1 per cent. of ferro-silicon the castings are grey throughout, and soft enough to drill or file.

The silicon in the untreated samples ranges from 1.7 to 2.25 per cent., and in the treated specimens from 2 to 2.75 per cent. I find that the addition of even so little as one pound of this alloy, in a powdered form, in a ladle containing 200 lbs. of foundry iron produces a remarkable effect, not only as a softener, but what is more surprising and equally valuable, it is invariably accompanied by an increase in strength and resilience, or ductility, of the metal, although we have added actually a little less than 0.25 per cent. of silicon to the iron. By adding four times this amount of the alloy to a very hard iron mixture of iron in a ladle which ran quite white when cast in thin sections, and was, therefore, entirely unsuitable for small castings requiring to be machined, I have found that I can produce a soft grey metal of good strength and ductility with low shrinkage, suitable for casting pulleys and other light work.

I am, of course, aware that it is not new to use brands of silvery iron, known as "softeners," containing 5, 10, or perhaps, even 15 per cent. of silicon, in the manufacture of iron castings, but so far as my experience goes in commercial practice, covering thirty years, the addition has been made in the cupola itself, which results in either what may be considered as a fixed product, or, if varied during the heat, in a product which is indeterminate, so as not to be predictable at a given moment of tapping.

I believe, therefore, that it is a new discovery to note the immediate diffusibility of the high-grade ferro-silicon when added to a relatively small quantity of melted cupola iron which has been withdrawn from the source of heat supply, and its capacity, when thus diffused, to produce definitely controllable results in the physical characteristics which are essential in different grades of castings.

The cost of the small addition of high-grade ferro-silicon in the ladle, even at the present price of the powdered alloy (about 4 cents per lb.), is trifling, and is far more than counterbalanced by the fact that lower grades of pig-iron may be used in the furnace, besides the practical value of being thus able to absolutely control the product and to vary the character of the metal in regard to softness, or machining quality, at the same time increasing the strength and ductility of individual ladles of iron drawn from one common source.

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PERMANENT MOULDS AND CARBON CORES.*

By Henry C. Caldwell.

The chill mould in which car wheels are cast is a success; that we concede, but inasmuch as it can be applied to no other work, it is not very interesting to foundrymen in general. The reason metal moulds have not been practical except for very low melting point metals is because unequal expansion rapidly destroys the mould if it is thick enough to prevent warping. The hot metal will expand the inner portion of the mould very much more than the radiating heat will expand the outer portion.

It has not been hard for experimenters to conclude that carbon was the logical thing from which permanent moulds should be made. This was because they had better results than with any other substance. Several inventors were so successful in their experiments that they secured patents on "carbon moulds"—two of them so long ago that their patents have expired by time limit.

Experiments are apt to be made with lead or aluminium, and so many duplicates produced from one mould that the inventor concludes that he has solved the problem only to find that when he pours gray iron or brass his mould ignites or gradually disintegrates from expansion and contraction, and that his only advantage over a metal mould is his low cost of production.

Like many others, the writer concluded, after carefully looking the ground over, that carbon was the only substance from which a permanent mould, in the sense we have in mind, would ever be made. He then began to study the problem and to repeat to himself the question—Why is is that theoretically we can make permanent moulds out of carbon but practically we cannot?

Having long since become a convert to the theory that all elements have their ignition point, and that the only difference between any two things is the difference in temperature at which they are created, or the speed and direction in

* Paper read before the Philadelphia Foundrymen's Association.

which they are going, I began to reason like this: Carbon will ignite in contact with oxygen when the temperature arrives at the right point, and the right point varies according to the kind of carbon and the kinds of carbon may vary according to the temperature at which they are produced.

For illustration take ordinary bituminous coal, place it in a retort and submit it to a temperature of 212 degrees F. and you will drive off steam, but you will not affect the other constituent parts. Raise the temperature and drive off a certain amount of volatile matter or gas and you will have left a piece of ordinary coke. This piece of coke will ignite if it comes in contact with molten metal provided the melting point of the metal is higher than the highest temperature to which the coke was submitted. Suppose, however, you had continued to raise the temperature of your retort until you had carried it beyond the melting point of steel, for instance; then, the point of ignition of the carbon would be above the temperature of the molten metal, and, as a consequence, it would not ignite when the metal was poured against it.

In order to test the theory, suppose you take a quantity of very fine, dry sawdust and apply a match to it. The result will be instantaneous ignition. Take the same quantity of the same kind of sawdust and subject it to a very high pressure, sufficient to reduce its bulk to one-tenth its original size, and see how much longer it will take you to ignite it. The pressure does the same thing in a modified way to the sawdust as the high temperature does to the coke, because temperature and pressure are really the same thing.

Theoretically, then, the permanent mould problem was solved. All I had to do was to get some carbon (coke) produced at a higher temperature than the metal I intended to cast.

I secured a quantity of the hardest coke I could find and made some moulds. I could pour aluminium castings indefinitely, but when I tried brass I soon destroyed the mould.

My next move was to subject the mould to a very high baking heat, with a view to raising the ignition point. In this I was reasonably successful; that is to say, I raised the point of ignition high enough to permit brass castings to be made, but I had changed the shape of the mould so that the castings were not like the pattern. This was due to two causes: First, the surfaces of the moulds, both inside and out, were disturbed by the gas as this temperature, which was higher than that at which the coke was produced, drove off; and, second, because in baking the mould the temperature of the oven was uneven, being hotter on the bottom than it was on the top, which resulted in the bottom expanding before the top and causing a number of small cracks which so weakened the mould that it soon went to pieces.

By this time I came to the conclusion that the coke would have to be produced in the first place at a temperature high enough to drive out all of the volatile matter that would come out at, say, 4,000 degrees Fah. Having been a student of temperature for many years, and having, as I believed, succeeded in producing a fire many degrees hotter than is considered possible by many recognised authorities on chemical combustion, I began to look for a method of applying my knowledge to the manufacture of coke. This was not very difficult, and in a short time I had what I was looking for and again proceeded to make moulds.

I found even this did not overcome all my troubles. It was still necessary to bake moulds, and it had to be done at a temperature so far above the melting point of the metal, that the limit, 4,200 degrees Fah., claimed by most scientists as the height of temperature possible by chemical combustion, would have to be very much exceeded.

I wanted an oven with a temperature absolutely uniform and even in every part—top, bottom, sides, and centre—and I wanted that temperature to be over 4,200 degrees Fah. You can readily understand that if my oven was to attain this temperature throughout I would have a temperature far above this outside the oven. It took many weary days and nights to work this out. In fact, it ran into months, and finally into years, but I succeeded.

Students and thinkers have latterly concluded that the only limit to temperature by chemical combustion is the means of controlling, or rather, containing it.

Moulds baked in a 4,000-degree oven will withstand any molten metal up to and including steel. They will not expand or contract, and seem to get better and better the longer they are used. If any of my hearers are sceptical they may test me out, and to this end I will launch a challenge at the risk of being convicted on the charge of boasting: I defy any of you to bring me a refractory substance, such as carbon points for arc lights, carborundum from the electrical furnaces at

Niagara, or pieces of crucibles that I cannot reduce in fifteen minutes. I would like to be in a position to demonstrate this whole matter to you all, but we are not yet through with the Patent Office, and until we are, self-preservation demands that we do not reveal our system or the construction of our furnaces except to the persons interested as stockholders in our company. Personally, it is my desire, and I think my duty, to give the results of my years of study to the world at large, demanding as a reward three meals a day and a place to sleep, but I am not in so fortunate a position, because three meals a day and a place to sleep have been advanced to me by friends who had confidence in me and the ultimate results and, further, because it will cost a good many dollars to make the world at large believe that I have done what is here claimed, and that I can do it again on a larger scale.

I think I hear some of you asking how I am going to take care of the shrinkage of the castings. It will surprise you to learn how many castings that at first seem incapable of being produced in permanent moulds can be very readily handled.

As a matter of fact, we have figured out how it will be possible to make almost every part in stove work, either in a permanent mould or parts of permanent moulds. The rings, for instance, will be made in moulds, the outsides of which will be permanent and the centres sand to take care of the contraction which is all inward, and the moulding machine will need a big handicap to beat us out.

The only question open is: How much carbon will be taken up by a steel casting?

My own opinion is that not enough will be taken up to change the analysis, for the reason that the mould will not give up anything if you keep below the temperature in which it was baked. A number of steel experts agree with me on this point, and none dispute me. My experiments have been very limited with steel, because by the time I get up to, and include iron, I am in a field so wide that I do not expect to feel cramped.

A step in advance often makes it necessary, or at least advisable, to take another. It was only a short step, but nevertheless a very important one, from the carbon mould to the carbon core, and then another one to the carbon core box.

Core boxes are made exactly the same way and out of the same material that we make permanent moulds. It is only necessary to have a core made in the usual way, or a pattern such as you would have to make a casting, then make the box in sections, put the sections together, hold the box under a hopper containing an absolutely dry powder, fill the cavity, shake it down a little and place the whole thing in an oven with about a 1,500-degree temperature, and in from five to thirty minutes, depending on size, the core is ready to take out of the box, and as soon as it cools enough to be handled it is ready for use. This will, as a matter of course, be much more valuable for intricate than plain work. By this system one is no more difficult than the other, but plain shapes are now made very cheap by the old process. Another great advantage is that a boy or a girl strong enough to lift the box can make a core as good as the most skilful core maker. Venting is practically done away with, as the red heat to which they are submitted drives out all the gas that was in the carbon and leaves the core so porous that it will easily take up all the gases that may be in the metal.

These cores may be kept indefinitely, and when we are through with them we grind them up and use the powder over again, or put them in our fire where they are worth almost as much for fuel as they cost to make originally. This material is much cheaper than any core compound I know of.

I did not select the proper binder for this powder the first time trying, and my advice to you is not to wear out any gray matter in an effort to learn what it is. I was standing on my head when I thought of trying it, and as very few of you would care to remain long in that position just bide your time for a few months and I will tell you all about it.

I have a very rapid process for making copper patterns, a thousand of which can be made, and they won't vary a 64th of an inch. Also a dry sand process that made possible the small cylinder shown you, and by which I have been doing some very interesting stunts in multiple moulding, but as they are really foreign to the subject of the evening we will not go into their field.

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THE firm of Graham, Morton, Limited, went into voluntary liquidation on December 27 last, but we are now informed that Mr. Maurice Graham, the founder and managing director of that firm, has decided to start in the same line of business on his own account, as a private concern, under the style of Graham, Morton & Company, Pepper Road, Hunslet, Leeds.

HEAT TREATMENT OF CAST IRON.

By P. Munnoch.

A short article on this subject may be of interest in connection with the recently published paper on "Cast Iron," read before the British Foundrymen's Association by Herbert Pilkington, M.I.C.E., M.I.M.E., Vice-President.

The accompanying typical diagrams and table will, no doubt, show the utility of a diagram from a transverse testing machine, and also the characteristic features of untreated and heat treated test bars.

These diagrams were obtained from a Keep's transverse testing machine on test bars 12 in. long by ½ in. square. The records are of distinct value as the total deflection is shown to consist of two separate properties, which are usually taken together and called "deflection." The diagram shows this to consist of elastic deflection and permanent deflection, the latter being very minute compared with the former. It is the permanent deflection which is most affected by heat treatment, such as annealing and quenching.

The method of taking the diagrams shown is slightly different to that recommended by Mr. Keep, the pencil being left in contact with paper from start to finish. This gives a continuous diagram. As the recorder multiplies the deflection five times, if the diagram is taken on sectional paper ruled in 1-5th in. squares, each of these equals 0.04 in.

After marking the base line, the load is first run along the beam to 300 lbs. As the weight travels the paper-holder moves along, and as the bar is gradually deflected downwards by the increasing load, the pencil marks a sloping line below the base line. On reaching 300 lbs. the beam is lifted up to take the load off the test bar, when the pencil rises vertically, almost to the base line. The weight is then run back to the starting point. This marks a straight line slightly below the base line showing the amount of permanent deflection. The load is put on again, this time up to 400 lbs.; the beam is again lifted and the weight returned to the starting point again. Then the load is run on to 500 lbs., and so on until bar breaks. Very few bars exceed 500 lbs.

In ½ in. square bars slowly cooled in sand after casting and tested as cast, the permanent deflection appears to depend to a great extent on the amount of phosphorus present. The lower the phosphorus the greater the permanent deflection, whilst irons high in phosphorus show very little of this property. As the total carbon is usually high with low phosphorus and low with high phosphorus, this may be partly due to the amount and condition of carbon present.

When grey cast-iron bars are annealed, the combined carbon is changed to temper carbon, or amorphous carbon, and the bars increase in length, about one third of the contraction being made up again. The strength is generally reduced, usually about 10 per cent. The total deflection is increased, due chiefly to increase of permanent deflection. The fracture appears darker and the bars are much softer for machining.

When annealed bars are heated and quenched in water there is little change to be noticed below about 650 degrees C., but above this each increase in quenching temperature until 800 degrees C. is reached, gives increased strength and deflection. Combined carbon also increases as the quenching temperature rises, from nil to 0.1 or 0.2 per cent., by the colour method, due to temper carbon recombining. The fracture now has a more dense black appearance than the annealed bars, and has a larger grain. Contraction remains the same as before quenching, and hardness is slightly increased. The result is much the same if ½ in. square bars are cooled in the open air instead of quenching.

When heated above about 850 degrees C. and quenched, the strength is greatly reduced. The total deflection is decreased and permanent deflection is practically absent. Combined carbon is increased, and may be much above the amount which was present in the bar when cast. The bars expand in length, and now may have lost half of the original contraction. The fracture is greatly changed and is now fine-grained and light coloured.

When bars as cast are heated and quenched, the results are much the same as with the annealed bars, except that the combined carbon is usually higher. This, however, depends to some extent upon the temperature attained and length of time the bar is kept heated previous to quenching. In the examples given the numbers in the table correspond to those of diagrams.

Summarising the results in a more simple way, the author may therefore state that direct quenching or reheating and quenching grey cast-iron from high

temperatures, say, above 870 degrees C., renders it excessively brittle and weak, greatly increase strength and toughness. The author has no doubt that for many

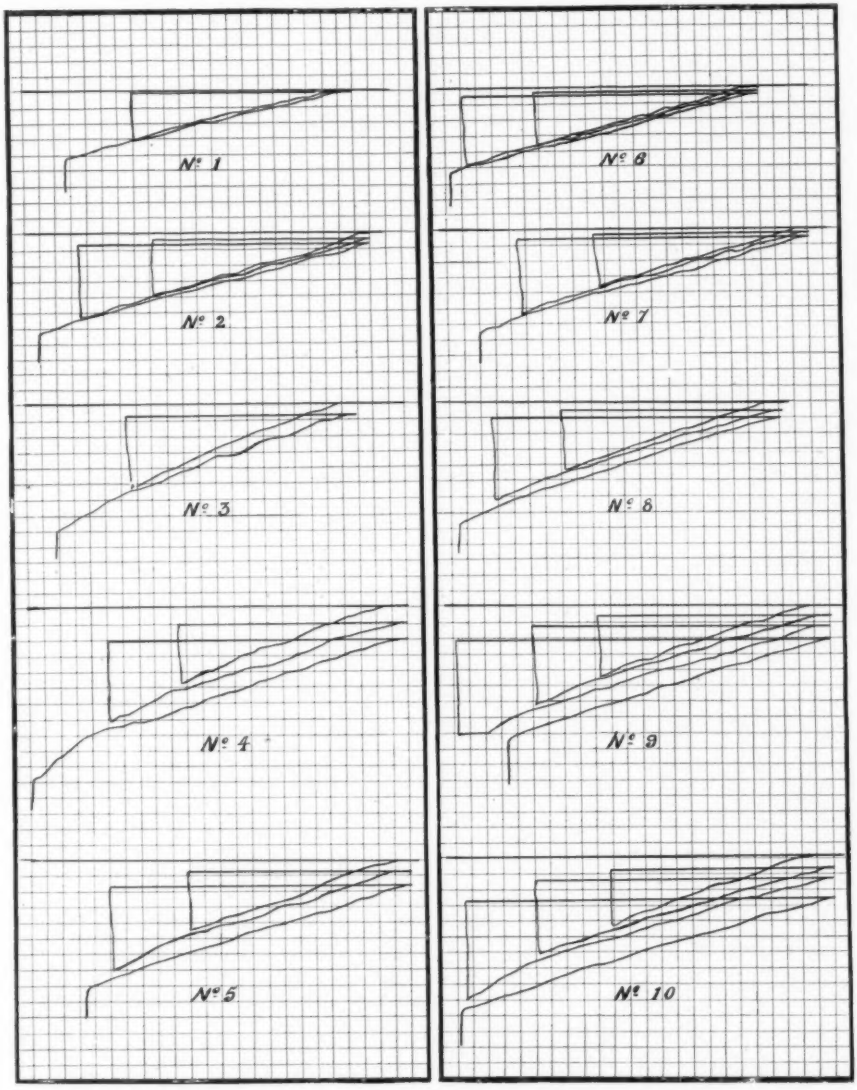

DIAGRAM FROM KEEP'S TESTING MACHINE.

but at temperatures only slightly below those which give these unsatisfactory results, the effect of rapid cooling is to

purposes the process can be applied with advantage to castings.

The following will illustrate the effect

of heating and cooling on combined carbon in grey cast-iron :—

No. 1)—Bar as cast, .45 per cent. combined carbon.
No. 2)—No. 1—Heated to 850° C. and slowly cooled, .18 per cent. combined carbon.
(No. 3)—No. 1—Annealed 24 hours in annealing furnace, combined carbon, nil.
No. 4)—No. 3—Heated to 850° C. and quenched, .35 per cent. combined carbon.
No. 5)—No. 3—Heated to 950° C. and quenched, .96 per cent. combined carbon.
No. 6)—No. 5—Heated to 950° C. again and slowly cooled, combined carbon, nil.

The effect of rapid cooling and quenching on test bars containing average amounts of combined carbon at temperatures below 850 degrees C., will no doubt give a sorbitic structure, and this appears to fully account for the altered physical properties. In the case of annealed bars, however, although quenching produces similar physical results, the amount of combined carbon usually present hardly appears sufficient to give a sorbitic structure which would account for these results.

The number given in the table below corresponds with those of the diagrams of page 83.

Tested.	No.	300 lbs.		400 lbs.		500 lbs.		Breaking.		
		Permanent deflection.	Total deflection.	Permanent deflection.	Total deflection.	Permanent deflection.	Total deflection.	Total deflection.	Strength.	
									lbs.	
As cast... ...	1	.005	.13	—	—	—	—	.18	390	High phosphorus
,, ...	6	.01	.14	.02	.20	—	—	.21	420	
,, ...	2	.02	.16	.03	.21	—	—	.25	460	Low phosphorus
,, ...	7	.01	.14	.04	.25	—	—	.25	455	
Annealed ...	3	.025	.22	.05	.33	—	—	.35	400	
,, ...	8	.020	.15	.04	.25	—	—	.30	445	
Annealed and air cooled	4	.015	.20	.09	.30	—	.44	.44	500	
	9	.025	.18	.05	.26	(at 470 lbs, .09	.33)	.34	450	
Annealed and quenched	5	.03	.18	.055	.29	—	—	.32	435	
	10	.03	.18	.06	.26	.11	.37	.35	505	

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TRADE TALK.

THE MANCHESTER STEEL CASTINGS COMPANY has started business at Trafford Park, Manchester.

A COMPANY is being formed to acquire the works and plant at Neath of Price's Engineering Company.

MESSRS. ROBERT STEPHENSON & COMPANY, LIMITED, have decided to build a new foundry at Hebburn.

MOFFATT, NEW & COMPANY, LIMITED, has been registered to carry on the business of founders, engineers, etc.

MESSRS. B. HARLOW & SONS, King Edward Street, Macclesfield, are supplying castings to the local Corporation.

THE STANTON IRON COMPANY, LIMITED, have an order to supply iron castings to the Bury and District Joint Water Board.

J. F. CLARK & SONS, LIMITED, has been registered to carry on the business of engineers, ironfounders, etc. The capital is £2,000.

THE LONDON, BRIGHTON AND SOUTH COAST RAILWAY COMPANY have decided to remove their wagon works to a new site at Lancing.

THE shareholders of the Albion Engineering Company, Limited, have resolved that the company be voluntarily wound up.

MR. H. DAVEY, M.I.C.E., has removed from Prince's Street to Parliament Chambers, Great Smith Street, Westminster, S.W.

FRANCIS MORTON & COMPANY, LIMITED, of Garston, Liverpool, are supplying 47 bridges of about 60 ft. span for the East Indian Railway.

MESSRS. F. JOHNSON & P. J. TUCKER, ironfounders, engineers, etc., Grove's Foundry, Kingston-upon-Hull, have dissolved partnership.

W. BATH & SON, LIMITED, (capital, £50,000, in £1 shares), has been registered to carry on the business of engineers, founders, etc.

THE BLAENAVON COMPANY have added to their works a new blowing engine of the turbine type, manufactured by Messrs. C. A. Parsons & Company.

BATES ENGINEERING COMPANY, LIMITED, has been formed with a capital of £2,000, in £1 shares, to carry on the business of iron and brass founders, etc.

WILLIAM E. CARY, LIMITED, is the style of a company formed to carry on the

business of anvil makers, brass founders, etc. Registered office: 37, Adelaide Street, Red Bank, Manchester.

THE directors of the Straker Steam Vehicle Company, Limited, have altered the name of the company to that of Sidney Straker & Squire, Limited, and the business of Straker & Squire has been incorporated in it.

MR. WILLIAM ALLAN has secured premises at Mark Quay, Sunderland, and has laid down plant for the manufacture of marine engineering specialities. The firm is styled William Allan & Company, Mark Quay Engine Works.

A DISSOLUTION of partnership is notified in connection with Messrs. H. C. Barrow and A. H. Wood, mechanical engineers, who traded under the style of the South-Eastern Engineering Company, at 42, Tarn Street, London, S.E.

THE two firms, Joseph Webb & Company, Irwell Forge and Rolling Mills, Bury, and Joseph Webb & Sons, Knowsley Street, Bury, have been converted into a private limited company, under the title of Joseph Webb & Sons, Limited.

THE BRITISH BOILER FLUID AND ENGINEERS' STORES COMPANY, LIMITED, 10, Church Row, Limehouse, London, E., have been awarded the contract for supplying the British Admiralty with their boiler fluid for the current year.

TASKER'S ENGINEERING COMPANY, LIMITED, is the style of a new company, formed with a capital of £25,000, in £1 shares, to acquire the engineering business carried on by J. H. R. Tasker, at 59 and 61, Blonk Street, and at Portmahon Works, Watery Lane, Sheffield, as Tasker's Engineering Company.

AT the annual dinner of the Fownes Forge and Engineering Company, Limited, East Jarrow, held recently, Mr. A. Fownes, calling attention to a Fownes' patent built stern frame, said it was decided to make stern frames on a principle which would revolutionise that form of industry. They had found out a method of applying the single plate rudder to the stern frame.

MR. E. W. CRAWLEY, of Leeds, has lately issued his annual pig-iron statistics. The little volume, as usual, consists of 53 years' statistics of Scotch iron, 30 years' of Cleveland iron, and 24 of hematite. The highest and lowest prices of copper and tin over the last 42 years are also given, as well as the daily prices of Scotch, Cleveland and hematite pig-iron during the last year, as compared with 1904.

AT the inquiry into the disaster at Charing Cross Railway Station on December 5, Sir Benjamin Baker said one of the ends where the tie rod broke showed a smooth surface in the centre, indicating that there had never been mechanical moulding at the centre of the bar. The flaw could not have been visible. The jury decided that the accident was due to the breaking of the tie rod, and attached no blame to any of the railway company's servants.

MESSRS. HENRY PELS & COMPANY, are supplying their Johns patent joist shears to Palmer's Shipbuilding and Iron Company, Limited, Jarrow-on-Tyne; John Booth & Sons, Bolton; Wm. Bain & Company, Coatbridge; and Heenan & Froude, Limited, Manchester. Orders have also been secured by the Company for their newly-designed Johns patent bevel cutting machines from Arrol's Bridge and Roof Company, Glasgow; Cleveland Bridge and Engineering Company, Limited, Darlington; A. & J. Main & Company, Limited, Glasgow; Alex. Findlay & Company, Limited, Motherwell; Brandon Bridge Building Company, Limited, Motherwell; and the Metropolitan Amalgamated Railway Carriage and Wagon Company, Limited.

A REPORT has been issued by the secretary of the Metallurgical Section of the Foundrymen's Association of America, in connection with the standardising of methods of analysing cast iron. The committee's method for the determination of silicon in pig-iron and cast iron is as follows:—Weigh 1 gram. of sample, add 30 c.cm. nitric acid (1.13 specific gravity); then 5 c.cm. sulphuric acid (conc.). Evaporate on hot plate until all fumes are driven off. Take up in water and boil until all ferrous sulphate is dissolved. Filter on an ashless filter, with or without suction pump, using a cone. Wash once with hot water, once with hydrochloric acid, and three or four times with hot water. Ignite, weigh, and evaporate with a few drops of sulphuric acid and 4 c.cm or 5 c.cm. of hydrofluoric acid. Ignite slowly and weigh. Multiply the difference in weight by 0.4702. The committee presented this method as one that sacrificed shortness to insure accuracy, and that left little to the judgment of the chemist. While it was recognised that it is almost impossible to get chemists to use a standard method in their daily work, the one proposed would serve as a check method in case of disputes between laboratories, or between buyer and seller.

PERSONAL.

Mr. Walker has retired from the general managership of the Dalmellington Iron Company.

Mr. L. T. O'Shea has been appointed Professor of Applied Chemistry to the Sheffield University.

The late Mr. J. A. Syme, a director of Stewarts & Lloyd's, Limited, left personal estate valued at £5,831.

The late Mr. R. G. Lewis, of Messrs. Lewis & Lewis, engineers, Derby, left estate of the value of £22,157 2s. 6d. gross.

Mr. C. H. Wilson, who has been created a peer, is a director of Earles Shipbuilding and Engineering Company, Limited.

Mr. C. Dyckerhoff has been admitted as a partner by Messrs. Ironside, Son & Company, 16, Water Lane, Great Tower Street, London, E.C.

The Right Hon. W. J. Pirrie, head of the firm of Harland & Wolff, shipbuilders, Belfast, has resigned his position on the Belfast Harbour Board.

The gross value of the estate left by the late Mr. A. Laing, a director of the Wallsend Slipway and Engineering Company, Limited, is £121,011.

The Tyneside Engine Works (Cardiff), Limited, have appointed Mr. F. C. N. Douglas as manager of their works at the Commercial Dry Dock, Cardiff.

The late Mr. J. Scott, formerly of the firm of Messrs. J. Scott & Company, shipbuilders and boilermakers, of Kinghorn, left personal estate valued at £7,870 10s.

Mr. W. B. Burdekin, secretary of Wm. Jessop & Sons, Limited, has resigned, and has accepted a seat on the Board. Mr. C. Howell has been appointed secretary.

Mr. D. G. Sutherland, chief engineer of the contract department of the works of Bruce Peebles & Company, Limited, has resigned and has been admitted a partner of the firm of Messrs. Mitchell, Graham & Son, engineers, of Edinburgh.

The late Mr. G. Evans, a director of Ben Evans & Company, Limited, and the Llanelly Steel Company, Limited, and chairman of R. Nevill & Company, Limited, has left estate of the gross value of £34,982 18s. 4d., including personalty of the net value of £24,989 13s. 4d.

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An order for 440 railway carriages for the Metropolitan Railway Company has been placed with a German syndicate.

QUERIES.

Casting Repair Parts.—Please say if it is legal to make castings for repair work to such things as parts for patent agricultural machines, ranges, gas engines, etc. Also, if anyone brought in a pattern off a patent, who would be held responsible, the giver of the order or the person who fulfils it?—"B."

Patching Up Furnaces.—Is ganister much superior and more economical than fireclay for patching up furnaces?—"Novice."

Defective Castings.—We have for some considerable time past been troubled with defective castings, similar to the enclosed, which is part of the rim of a pulley, and the bottom edge of it. As it gets nearer to the top of moulds the castings are worse. We do not mean to say that all our castings turn out like this; but this is one of the worst we have ever had, and thinking, perhaps, you could assist us in solving the mystery, we take the liberty of sending you this piece of metal, and shall be glad to hear any suggestions from your readers.—"W."

Casting Bronze Round an Iron Centre.—"D. B." writes:—"We have tried casting a number of gun-metal and also phosphor bronze rings around a cast-iron centre, which we heat to a dark red before pouring around our bronze or gun-metal. These rings vary from 12 in. diameter to 5 ft. diameter, and from 1 in. to 3 in. in thickness, and 2 in. to 6 in. in width. We have deep grooves to cut into these rings, but have been sorely troubled with their showing blow-holes when we machine down into them. Is there any way of overcoming this?"

Mr. J. Clements writes:—If "D. B." can cast the above rings at two operations, viz., first cast half the thickness and then finish by a second operation, he may overcome the difficulty. If it could be done vertically, then, no doubt, he would attain an even more pronounced success.

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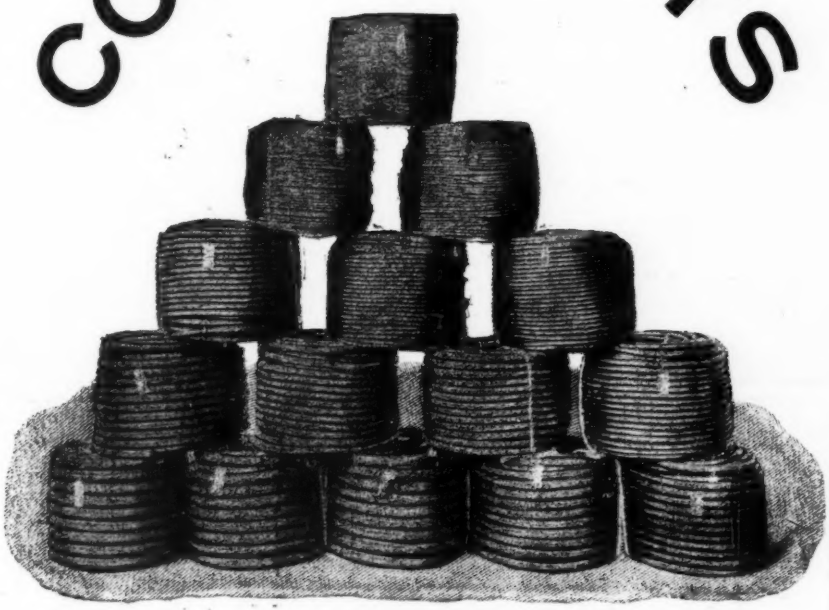
The Isca Foundry Company, Limited, of Newport, Mon., are supplying the Aberavon Gas Committee with 12 tons of 3-in. socket and spigot cast-iron pipes with grooved sockets (coated), each pipe to weigh 1 cwt. 0 qr. 8 lbs., and six tons of 4-in. socket and spigot cast-iron pipes with grooved sockets (coated), each pipe to weigh 1 cwt. 1 qr. 19 lbs., at £5 4s. 6d. and £5 3s. 6d. per ton respectively.

EVANS'S

CORE VENTS



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OBITUARY.

Mr. S. H. Swire, a director of the Wigan Coal and Iron Company.

Mr. T. White, of Kirkby Lane, Thorpe Hesley, retired screw and bolt manufacturer, at the age of 81 years.

Mr. E. Sykes, the managing director of John Sykes & Sons, Limited, machine makers, Tunbridge, Huddersfield.

Mr H. J. Young, Junr., eldest son of Mr. H. Young, of Messrs. H. Young & Company, Nine Elms, at the age of 36.

Mr. George Dove, aged 89, joint-managing director of Messrs. Cowans, Sheldon & Company, engineers, Carlisle.

Mr. E. S. Williams, in his 69th year, who established the firms of Messrs. Elford, Williams & Company and Messrs. Williams & Mitchell.

Mr. C. T. Yerkes, the railway magnate and pioneer of electric traction, whose name will be remembered as prominent in this country in connection with the electrification of the Metropolitan Railway in London some short time back.

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Bristol, October 25th, 1904.

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From MOUNTFORT PHILLIPS & Co., Llantrissant.

Llantrissant, October 25th, 1904.

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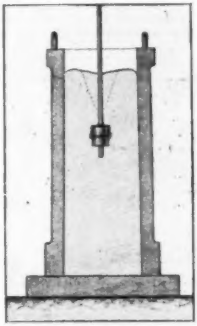

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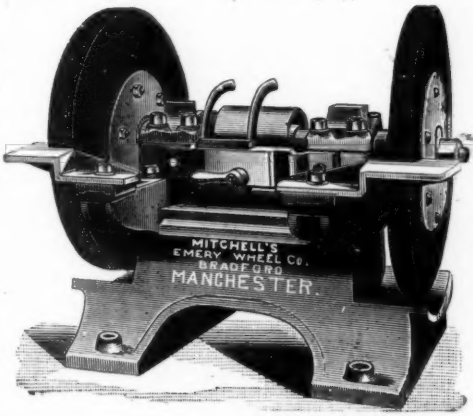

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PRICES OF METALS.

The following table shows the approximate latest prices and position of stocks of metals during the past two years :—

METALS.	1905-6.	1904-5.
Iron—Scotch pig warrant ... ton	—	—
—Middlesbro' warrants ... ... ton	52/9	47/9½
—W.C. M/nos Bessemer ... ... ton	70/6	58/0
—Stock, Scotch, Jan. 31 ...tons	14,700	13,800
Copper—Chili bars, GMB ... ... ton	£78 12 6	£68
—Stock, Europe & afloat... ... tons	10,951	15,733
Tin—English ingots ton	£168 15 0	£133 5 0
—Straits ... ton	£166 5 0	£131 15 0
—Stock, Ldn. Hlnd and aflt ... tons	—	—
Lead—English pig ton	£16 12 6	£13
Spelter—Ord. Silesian ... ... ton	£27 5 0	£21 17 6
Quicksilver-(75lb.) bottle	£7 7 6	£7 12 6
Antimony—Regulus ... ... ton	£65 0 0	£38

CASTINGS.

In the Cleveland district the following are the nominal rates current for castings :—

	£ s. d.		£ s. d.
Columns (plain)	6 12 6	to	7 2 6
Pipes, 1½ to 2½ in.	5 2 6	to	5 5 0
,, 3 to 4 in.	4 15 0	to	4 17 6
,, 5 to 8 in.	4 12 6	to	4 15 0
,, 10 to 16 in.... ...	4 12 6	to	4 15 0
,, 18 to 24 in.... ...	4 12 6	to	4 15 0
Chairs	3 15 0	to	3 17 6
Floor plates (open sand)	3 2 6	to	3 5 0

SCRAP.

The quotation for scrap subject to market fluctuations is as follows: —Engineers' heavy scrap, 57s. 6d. to 60s.; ditto light scrap, 25s. to 27s. 6d.; clean scrap brass, 47s.; clean scrap copper, 72s.; lead (usual draft), 13s. 9d.; tea lead, 12s. 3d.; zinc, 20s. 9d.; hollow pewter, 105s.; black pewter, 70s. per cwt.

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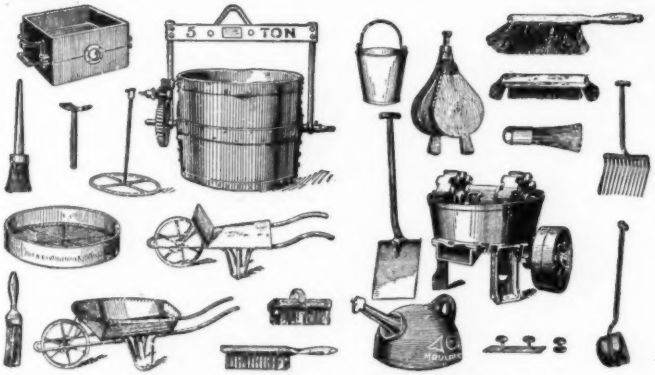

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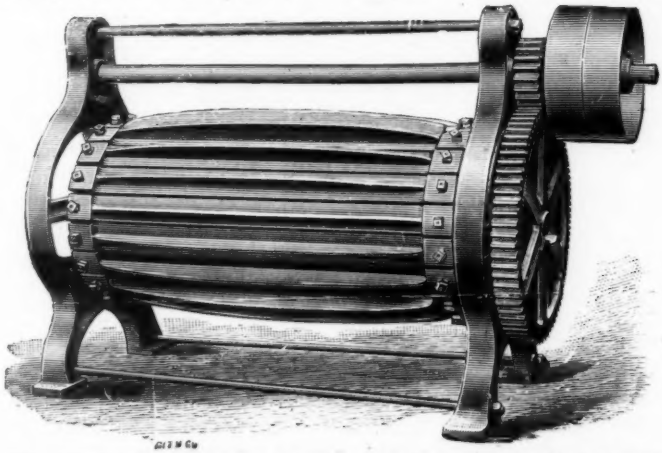

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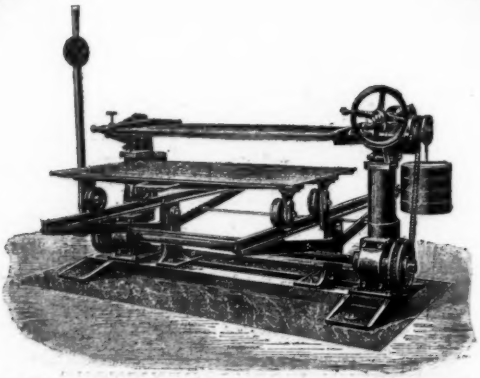

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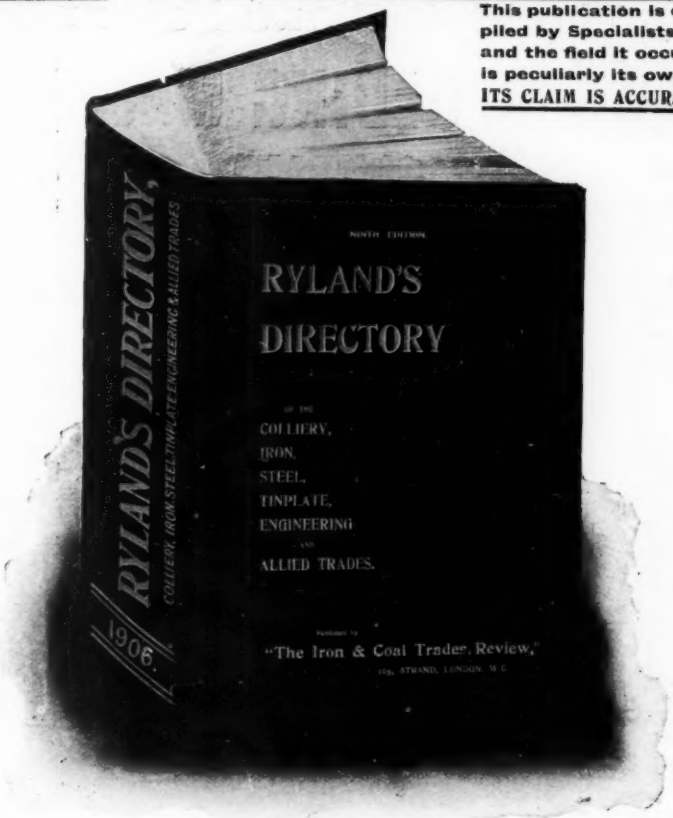

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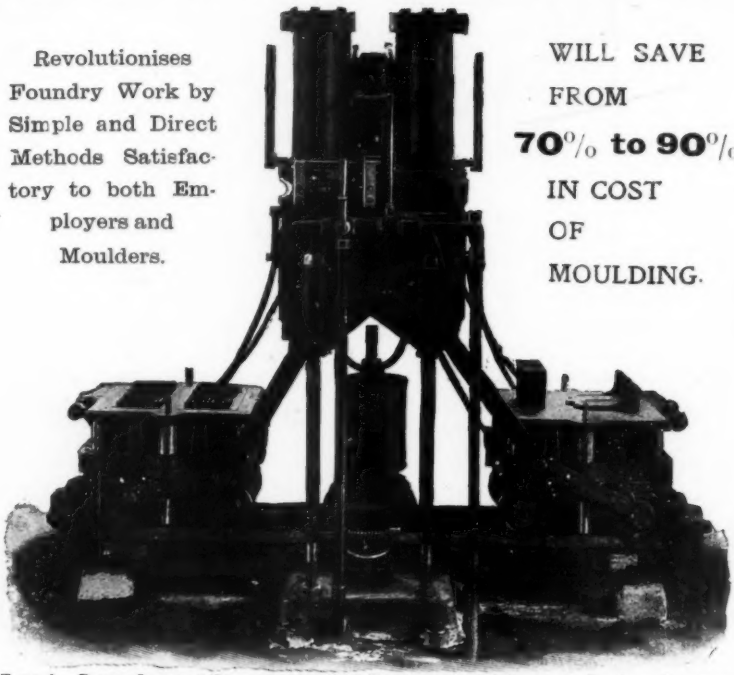

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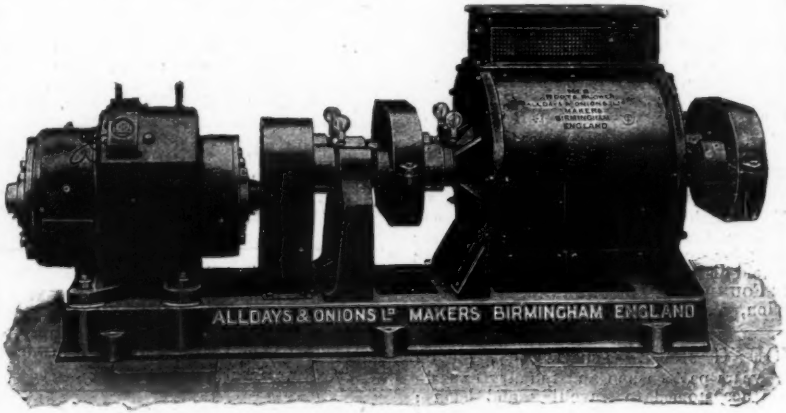

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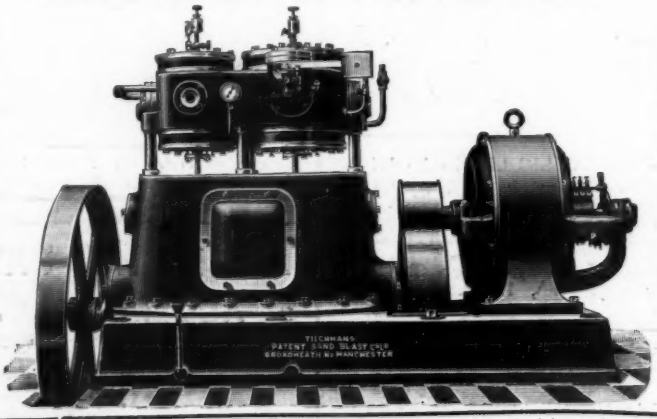

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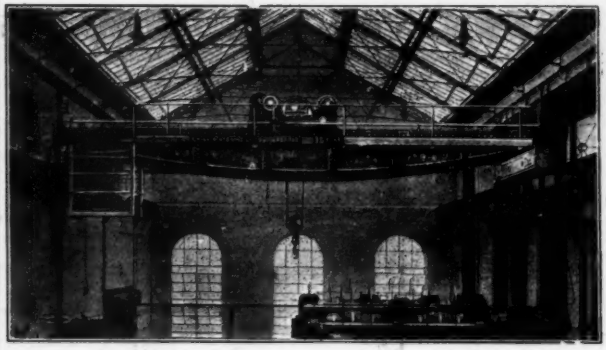

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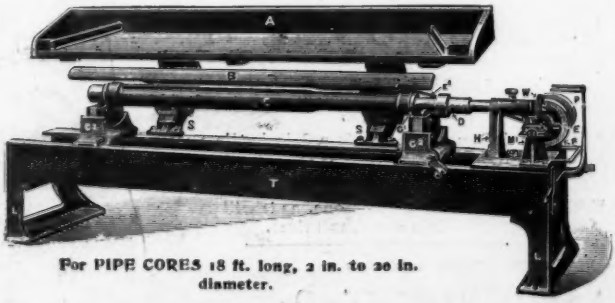

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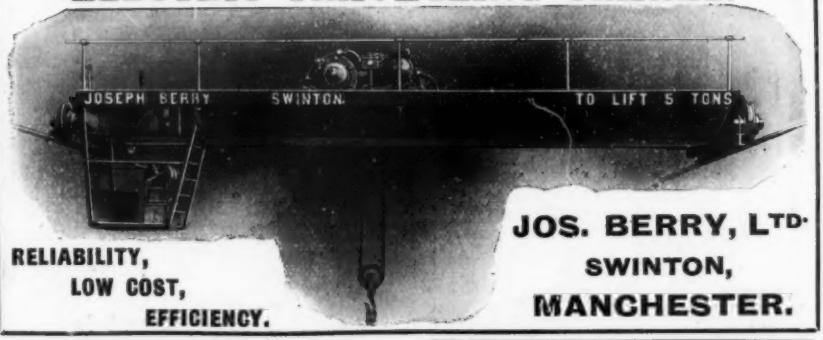

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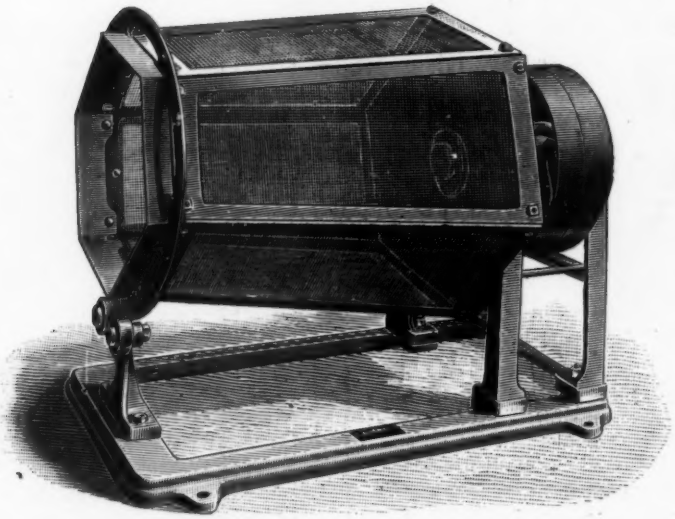

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